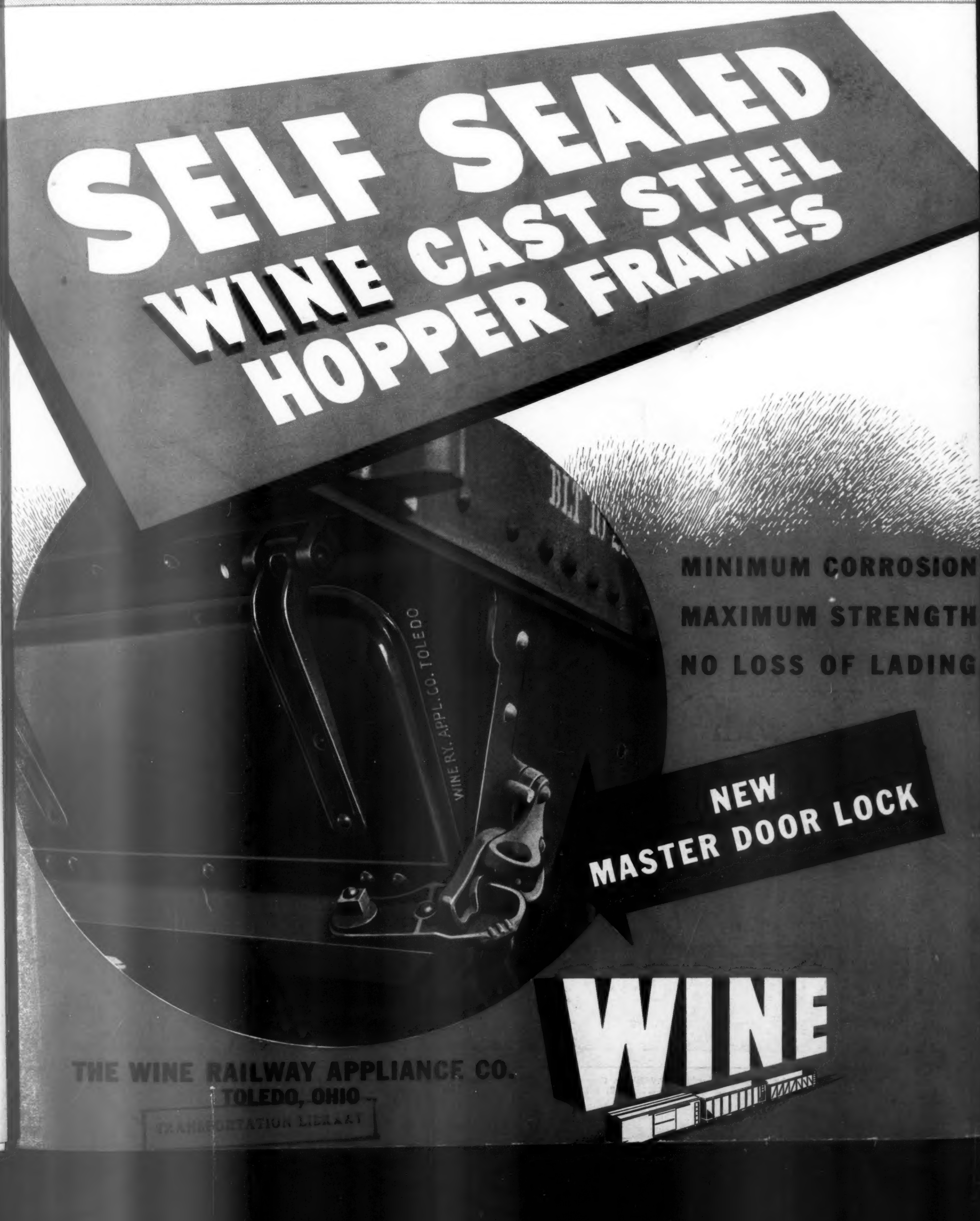
January
1943

Railway Mechanical Engineer

With which is incorporated RAILWAY ELECTRICAL ENGINEER



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THE EDITOR'S DESK

ALL RECORDS SMASHED! BUT WHAT LIES AHEAD?

The year 1942 promises to stand out in prominent relief in American railway history for a long time. After years of depression, but with a good running start prior to Pearl Harbor, the railways in 1942 smashed all records in both freight and passenger traffic.

As Dr. Julius H. Parmelee, director of the Bureau of Railway Economics, A.A.R., points out in an annual review article in the Railway Age, the freight train load in 1942 increased to 1,030 net tons, and the passenger train occupancy to 115. Expressed in another way by President J. J. Pelley of the A.A.R., the volume of freight traffic handled was 33 per cent greater than in 1941, the previous record year; and passenger traffic was 13 per cent greater than that of 1920, which marked the previous high spot. Record levels were also achieved in ton-miles per freight-train hour, average car load, car-miles per freight-car day, and the daily mileage run by both freight and passenger locomotives.

In spite of general recognition of the fact that the railroads are essential to the successful prosecution of the war, the authorities at Washington have felt that materials and equipment required by the railroads were of secondary importance to the building and supplying of ships and munitions. By superhuman efforts the railroad managements and workers, handicapped as to materials, equipment and manpower, have thus far successfully met the demands made upon them. Whether they can continue to do so is a question which involves a number of indeterminate factors. For one thing, no one can predict with any certainty, not even those in the inner councils, what major shifts may have to be made in our production processes as the fortunes of war sway back and forth and new and baffling challenges develop.

Certainly no effort must be spared by the railroads to continue to make the best possible use of every man-hour and every ounce of material available. Let us hope, also, that the War Production Board will find ways and means of giving the railroads a better break in releasing much needed materials and equipment to them. That Board took a long gamble last year and won out because of the spectacular speeding up of efficiency in railroad operation and in maintenance of the facilities and equipment in prime condition. There are limits, however, beyond which it will be impossible to go, in spite of the best of intentions and Yankee ingenuity.

Here's hoping for the best in the months to come!

Roy V. Wright

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Railway Mechanical Engineer—Railway Electrical Engineer

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RAILWAY
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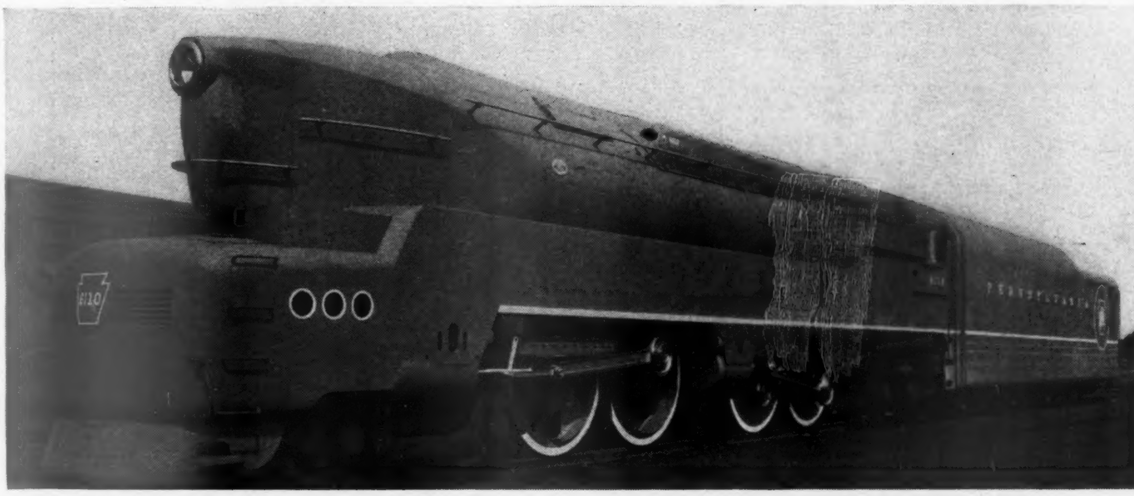


Pennsylvania T-1 Locomotives

Non-articulated 4-4-4-4 type passenger locomotives are designed to handle a trailing load of 880 tons at a speed of 100 m.p.h. on level, tangent track—Steam distribution system utilizes poppet valves.

About four years ago the Pennsylvania, in collaboration with the builder's engineering staff, initiated development work on a steam locomotive possessing operating characteristics comparable with the Pennsylvania Class GG-1 electric locomotives. Early in 1942 two high-speed passenger locomotives of the 4-4-4-4 type went into service. These two locomotives built by The Baldwin Locomotive Works, known as the T-1 class and bearing road numbers 6110-6111 are now being used in mainline service between Harrisburg, Pa., and Chicago. They are designed to cover this territory with only one stop for fuel and to have capacity to handle an 880-ton trailing load on level tangent track at 100 m. p. h.

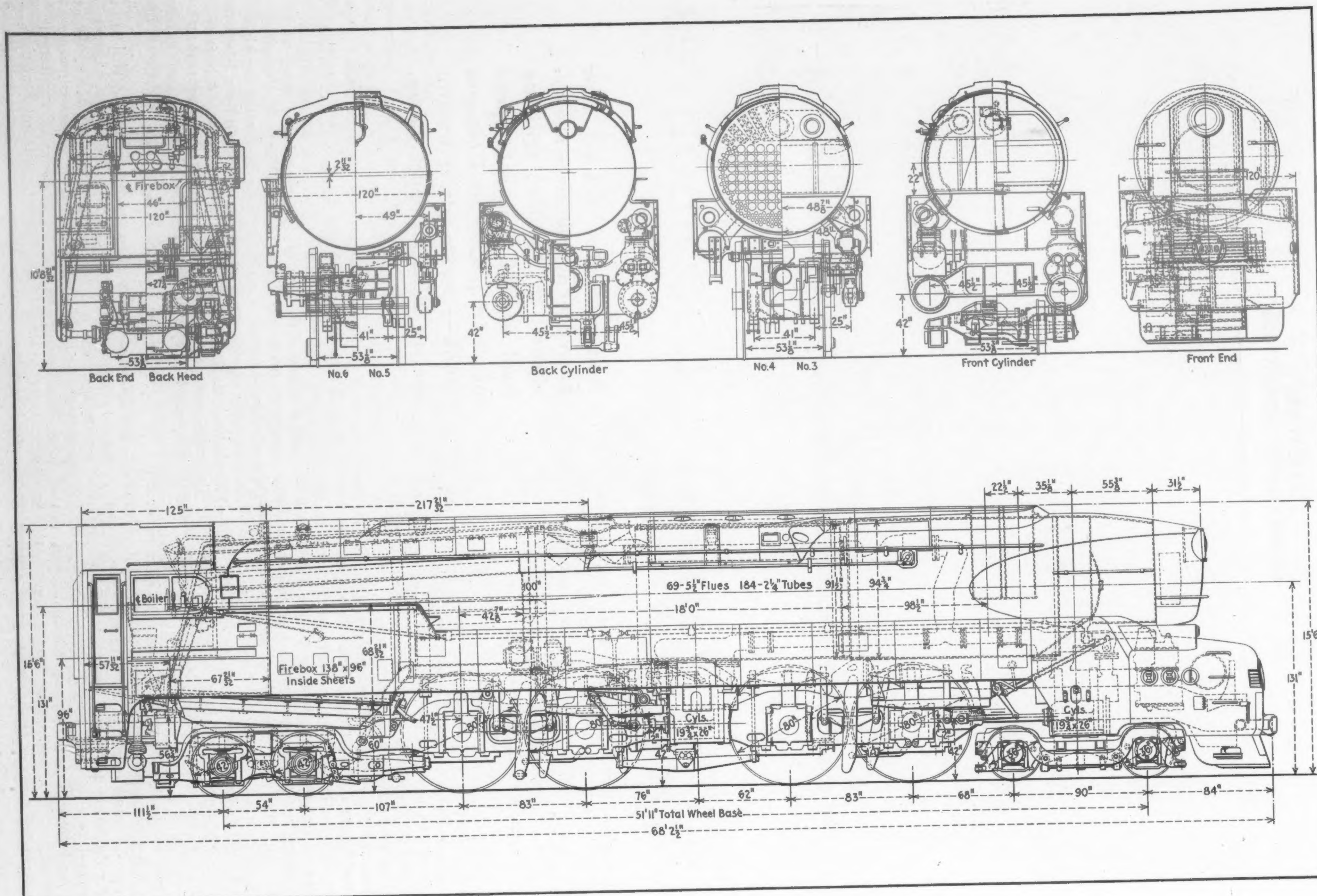
The T-1 Class has the general characteristics of the 6-4-4-6 locomotive exhibited at the New York World's Fair, with the important advantage that they can be operated in any main-line territory of the Pennsylvania. The order for these locomotives was placed in July, 1940, and they were completed in April and May, 1942. The tractive force of the locomotives is 65,000 lb. plus 13,500 lb. for the booster with which one of the two units is equipped. They have a driving-wheel base of 25 ft. 4 in. and a total engine and tender wheel base of 107 ft. 0 in.

These locomotives have a nominal capacity equivalent to a 4-8-4 but the 4-4-4-4 wheel arrangement permits the use of small cylinders with reduced piston loads, lighter machinery parts and lower piston speed. While the wheel base is long, lateral motion devices on the first and third drivers permit 15-deg. curves to be traversed.

Outstanding features of the design are the steam distribution system using poppet valves and the development of a clasp brake on the drivers and the trailer truck which embrace the use of flangeless brake shoes and which results in the elimination of hitherto objectionable unbalanced forces. Coincident with the demand for high capacity for long-run operation within definite wheelbase limits is the necessity for weight reduction in running-gear parts which has been solved by the use of alloy steel of special characteristics.

Steam Distribution System

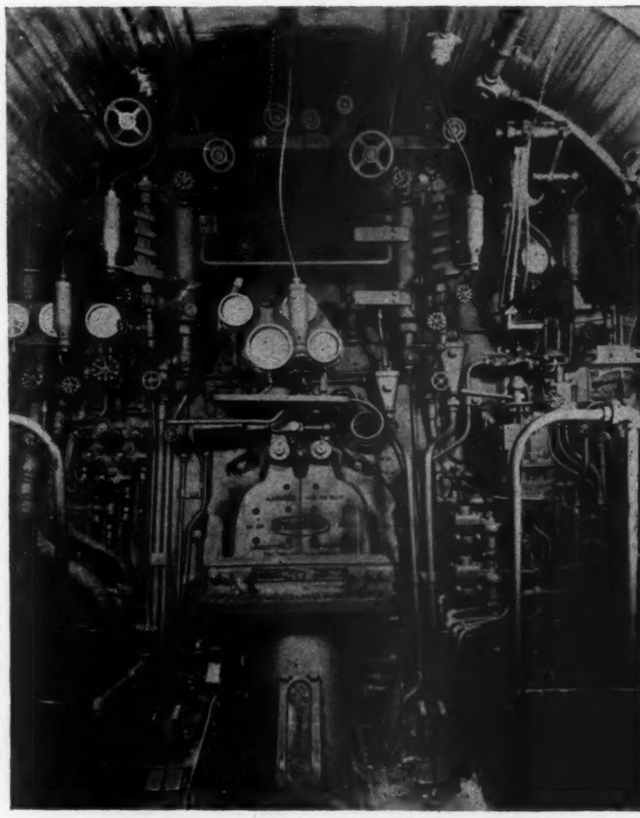
The Franklin system of steam distribution, applied to these locomotives, consists of four major units. These are the cylinders and related parts, the cam boxes, the gear boxes—one for each engine—and the power reverse gear. Except for the peculiar problems of application with respect to these four-cylinder locomotives, the equipment is like that used on Pennsylvania locomotive No.



Elevation and cross-sections of the Pennsylvania 4-4-4-4 type locomotive

General Dimensions and Weights of the Pennsylvania T-1 Class Locomotives

Builder	Baldwin Locomotive Works	
Type of locomotive	4-4-4-4	
Road class	T-1	
Road numbers	6110-6111	
Date Built	May, 1942	
Service	Passenger	
Dimensions:		
Height to top of stack, ft.-in.	15— 6	
Height to center of boiler, ft.-in.	10—11	
Width overall, in.	10— 7	
Cylinder centers, in.	91	
Weights in working order, lb.:	(without booster)	(with booster)
On drivers	268,200	267,840
On front truck	100,200	102,360
On trailing truck	128,800	138,200
Total engine	497,200	508,400
Tender (fully loaded)	433,000	433,000
Wheel bases, ft.-in.:		
Driving	25— 4	
Rigid	18— 5	
Engine, total	51—11	
Engine and tender, total	107— 0	
Wheels, diameter outside tires, in.:		
Driving	80	
Front truck	36	
Trailing truck	42	
Engine:		
Cylinders, number, diameter and stroke, in.	4—19¾ x 26	
Valve gear, type	Franklin	
Valves, poppet:		
Intake, number and diameter, in.	16— 5	
Exhaust, number and diameter, in.	16— 6	
Maximum lift, intake, in.	1	
Maximum lift, exhaust, in.	¾	
Cut-off in full gear, per cent	75	
Boiler:		
Type	Modified Belpaire	
Steam pressure, lb. per sq. in.	300	
Diameter, first ring, inside, in.	89¾	
Firebox length, in.	138	
Firebox width, in.	96	
Height, mud ring to crown sheet, back, in.	70 1/16	
Height, mud ring to crown sheet, front, in.	87 11/16	
Combustion chamber length, in.	96	
Circulators, number	5	
Tubes, number and diameter, in.	184— 2¼	
Flues, number and diameter, in.	69— 5½	
Length over tube sheets, ft.-in.	18— 0	
Net gas area through tubes and flues, sq. ft.	9.55	
Fuel	Bituminous coal	
Grate area, sq. ft.	92	
Heating surfaces, sq. ft.:		
Firebox and comb. chamber	419	
Arch tubes	None	
Circulators	80	
Firebox, total	499	
Tubes and flues	3,719	
Evaporators, total	4,218	
Superheating	1,680	
Combined evap. and superheat	5,898	
Tender:		
Style	Rectangular U	
Water capacity, U. S. gal.	19,500	
Fuel capacity, tons	41	
Trucks	eight-wheel	
General data, estimated:		
Rated tractive force, engine 85 per cent, lb.	65,000	
Rated tractive force, booster, lb.	13,500	
Total rated tractive force, lb.	78,500	
Speed at 1,000 ft. per min., piston speed, m.p.h.	55.0	
Piston speed at 10 m.p.h., ft. per min.	182.1	
R.p.m. at 10 m.p.h.	42.0	
Weight proportions:		
Weight on drivers + weight engine, per cent	54.0	
Weight on drivers + tractive force	4.13	
Weight of engine + evaporation	118.2	
Weight of engine + comb. heat. surface	84.4	
Boiler proportions:		
Firebox heat. surface per cent comb. heat. surface	8.4	
Tube-flue heat. surface per cent comb. heat. surface	63.0	
Superheater heating surface per cent comb. heat. surface	28.5	
Firebox heat. surface + grate area	5.43	
Tube-flue heat. surface + grate area	40.42	
Superheater heating surface + grate area	18.3	
Comb. heat. surface + grate area	64.0	
Gas area, tubes-flues + grate area	0.14	
Evaporative heating surface + grate area	45.8	
Tractive force + grate area	703.0	
Tractive force + evaporative heat. surface	15.4	
Tractive force — comb. heat. surface	11.00	
Tractive force x diameter drivers + comb. heat. surface	878.0	



The controls in the cab are conveniently arranged

5399 which was described in detail in previous articles.*

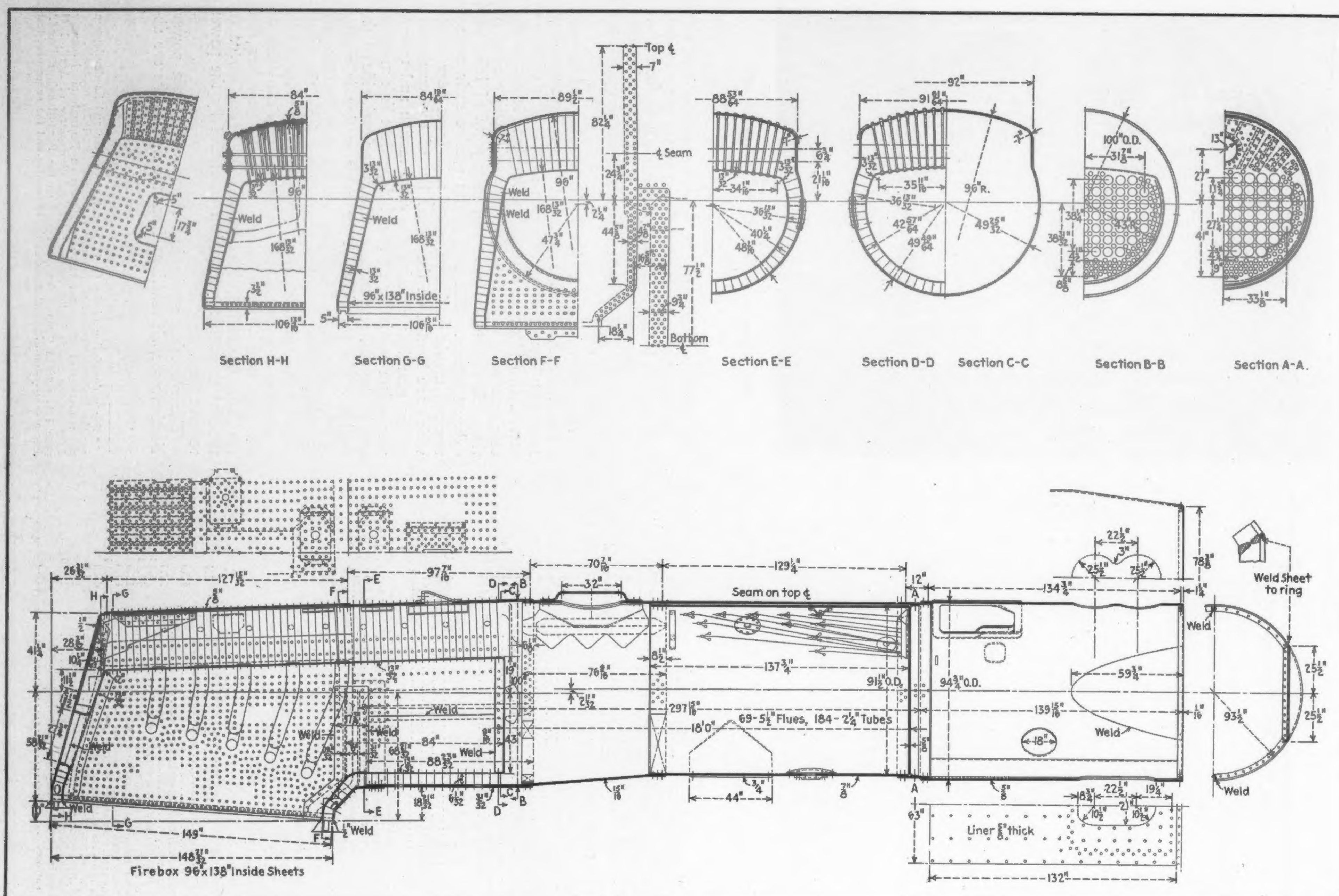
Each of the four cylinders has a steam chest at each end of the barrel and each steam chest contains two inlet and two exhaust valves of the horizontal double seated type. The exhaust valves are located nearest the cylinder barrel.

The eight valves of each cylinder are operated through a cam box located in the space between the steam chests. Each cam box contains two cam shafts, each of which carries two identical cams. Intermediate levers in the cam box with rollers bearing against opposite sides of these cams, actuate front and back pairs of inlet and exhaust valves. The cam shafts receive their motion through cranks and connecting rods from gear boxes which are located on the center line of the locomotive.

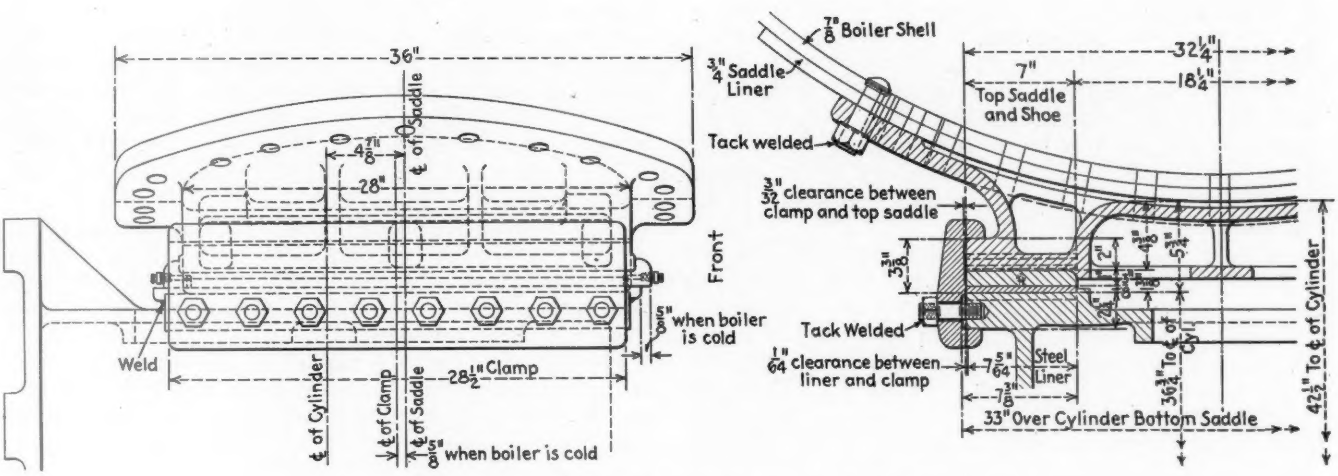
The gear box contains the valve motion and reverse mechanism consisting of four independent link motions, one intake and one exhaust motion for each side of the engine. The principle of the valve motion is similar to that of a Walschaert gear except that the lnks are not driven from an eccentric crank but from the crosshead of the opposite side. This motion is imparted by a connection to the engine crosshead from each side of the gear box. The links are inside the gear box and the link "blocks" (rollers in this case) are moved in the slot through a mechanism controlled by the power reverse gear.

The reversing mechanism requires but little power. Furthermore, all reactions from the link blocks are ab-

* For a description of the O. C. poppet valve gear and its development see the *Railway Mechanical Engineer* for September, 1939, page 349. For the road tests of the poppet valve installation on Pennsylvania locomotive 5399 see the article in the *Railway Mechanical Engineer* of April, 1941, page 125, entitled "Poppet Valves Tested on the Pennsylvania Railroad." For a description of the changes in the locomotive and the subsequent tests on the Altoona test plant, see the article in the *Railway Mechanical Engineer* of May, 1941, page 169, entitled "Poppet Valves Tested at Altoona."



The boiler of the Pennsylvania Class T-1 locomotive



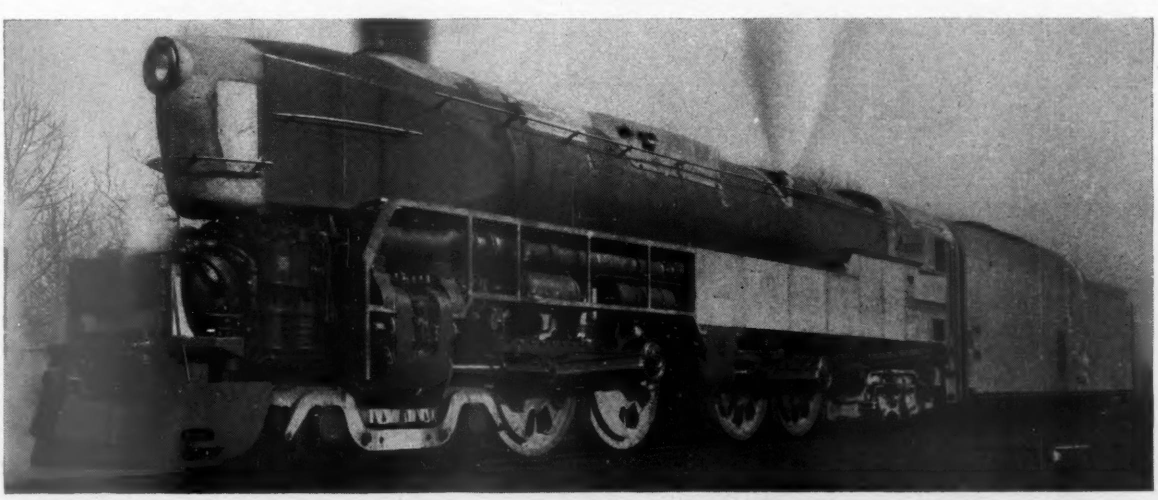
Details of the sliding boiler support at rear engine cylinders

sorbed by reach-rod screws located within the gear box. Therefore, power is needed only for reversing, and not for holding the gear in a certain cut-off.

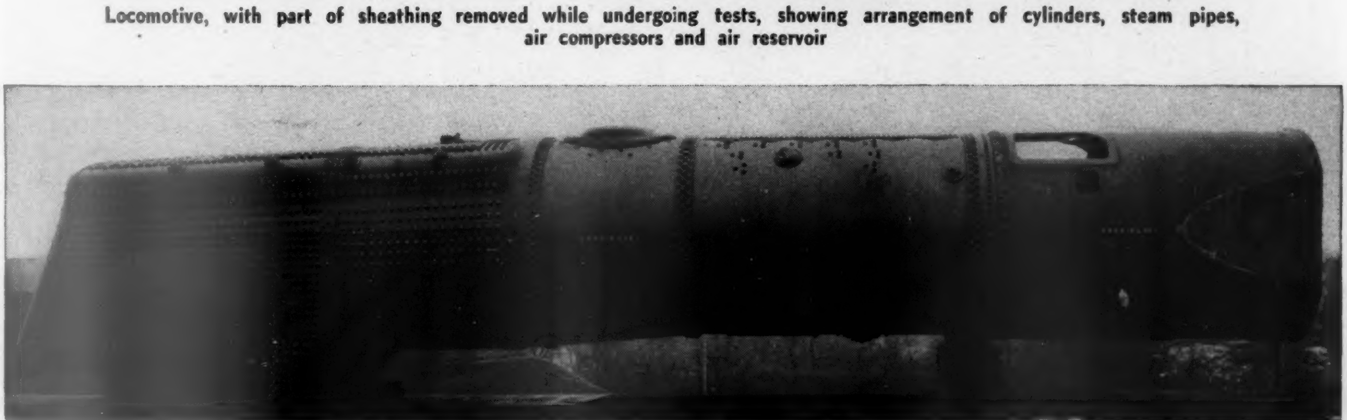
In view of these facts, and to comply with the law, a small power reverse gear has been designed to operate the operating mechanism. This reverse gear is located entirely within the cab and is connected to the gear box by rotating connecting shafts equipped with universal joints. Expansion joints incorporated in the universal joints allow the shafts to expand or to contract in length.

The power reverse gear is operated by a small air motor controlled by a valve and hand lever. An indicator shows the cut-off positions for forward and backward gear. The air motor is equipped with a bevel gear driving another bevel gear keyed to the reversing screw shaft. At the front the screw shaft connects to the reverse connecting shaft leading to the gear box through bevel gears and universal joints.

The above is a general description of the several units of the steam distribution system. On these locomotives the application of the several units involved some interesting problems brought about by clearance limitations within the running gear. The gear boxes, located on the center line of the engine, are located directly ahead



Locomotive, with part of sheathing removed while undergoing tests, showing arrangement of cylinders, steam pipes, air compressors and air reservoir



The boiler has a modified Belpaire type firebox

of or behind the cylinder. In the case of the front engine the gear box is mounted, in a horizontal position, ahead of the front cylinders. The motion of each engine crosshead—right and left side—is imparted to a transverse shaft by links and lever arms and, in turn, to the cranks on the gear box by other connecting rods. The screw shaft of the gear box receives the rotary motion from the reverse gear shaft through a connection at the rear end of the gear box.

The gear box for the rear engine is identical in design to that of the front engine gear box but is mounted vertically against the back surface of the rear engine cylinders. The driving mechanism from engine crosshead to gear box is similar in principle though different in arrangement due to location problems. The screw shaft of this gear box is connected to the rotating shaft from the power reverse gear at the top of the box.

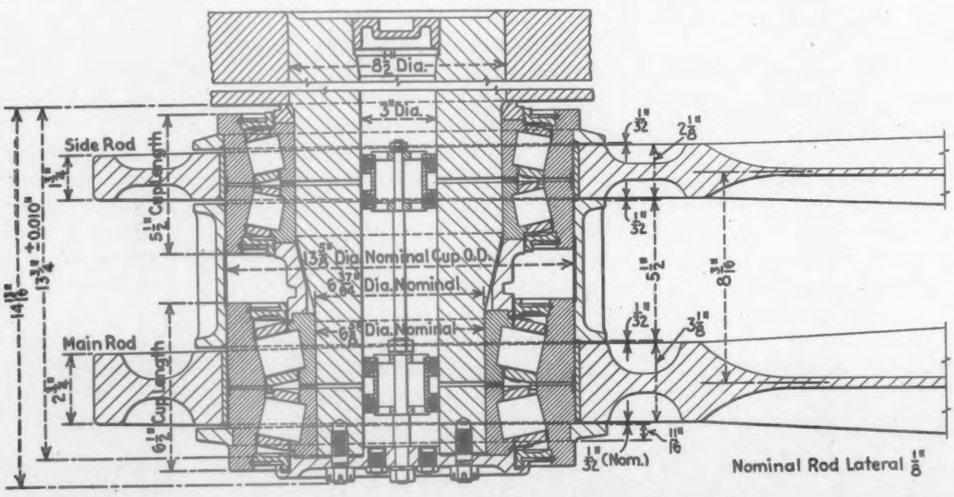
The Boiler and Appurtenances

The boiler is the straight top type with a modified Belpaire firebox. The overall length is 50 ft. 1$\frac{1}{16}$ in. and the maximum width over firebox sheet is 9 ft. $\frac{1}{16}$ in. The width at the top of the firebox tapers from 84 in. at the back to 92 in. at the front, over the combustion chamber. The first course is 89¾ in. inside and the second course increases from 91½ in. to 100 in. outside.

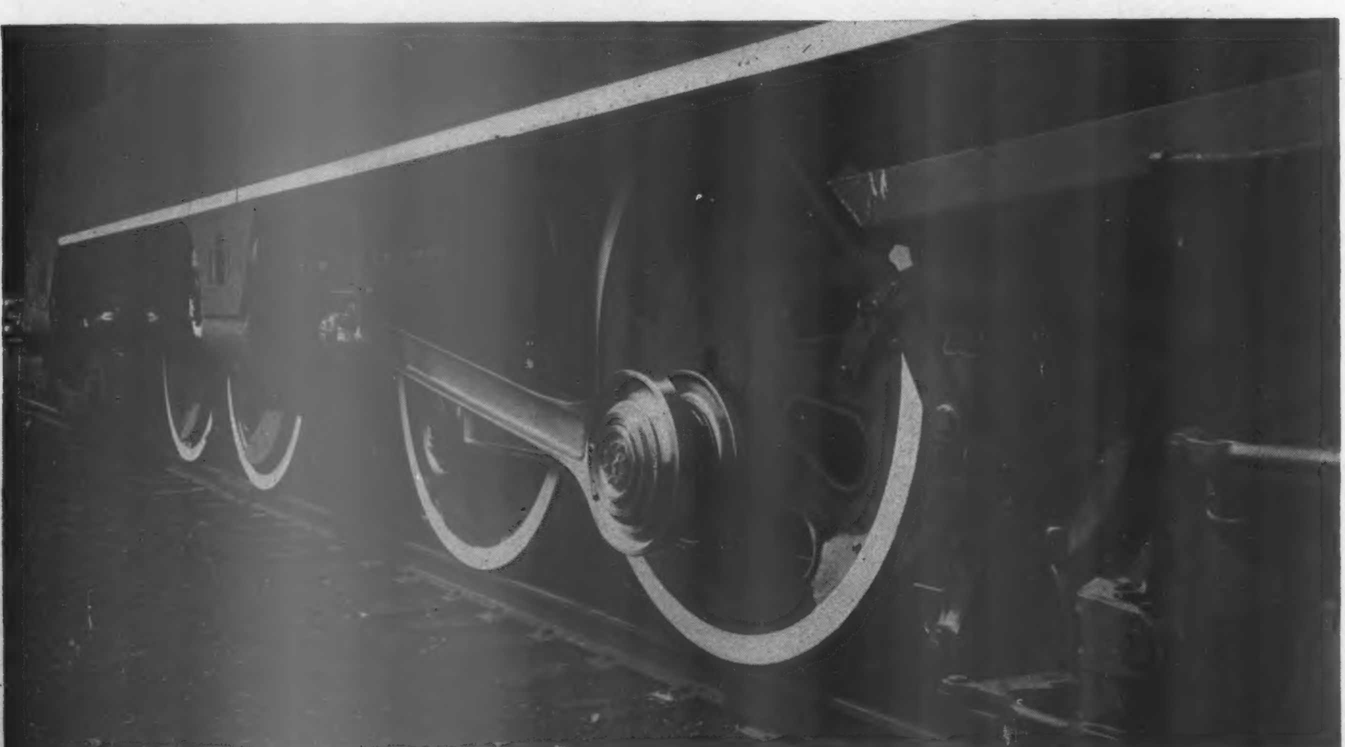
The firebox is 138 in. long, 96 in. wide and the combustion chamber is 96 in. long.

The shell-course sheets are ⅞ in., $\frac{15}{16}$ in. and $\frac{31}{32}$ in., and the firebox and combustion chamber sheets vary in thickness from $\frac{13}{32}$ in. to $\frac{19}{32}$ in. Nickel steel was used for the shell, welt strips, top wrappers, back head, dome and front tube sheets.

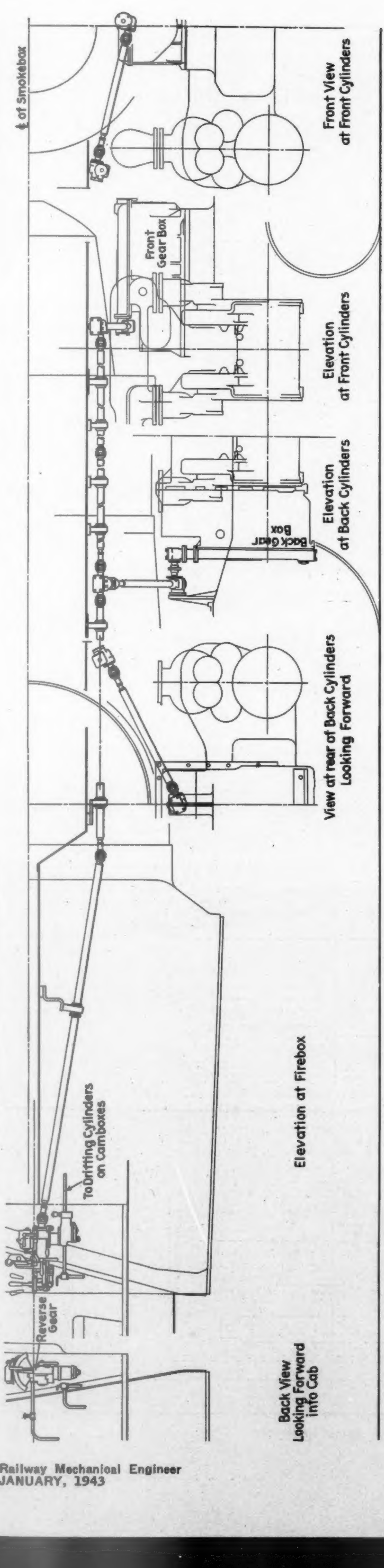
Flexible staybolts are applied in the breaking zones of the firebox in two boundary rows of the side sheets and back head, in the throat sheet, and in the combustion chamber below the crown sheet. Four rows of expansion stays are used at the front of the combustion chamber. Rigid water-space stays and transverse stays for the Belpaire firebox complete the installation.



At the main crank pin separate bearings are used for the main and side rods. The rods may be removed without disturbing the bearing assembly



The running gear, showing roller-bearing rods and crossheads



Control mechanism for valve gear is designed with bevel gears, universal joints and expansion joints

The construction of the boiler involved the use of welding in several places. The firebox and wrapper sheets are riveted and welded to the mud ring; the wrapper is seal welded to the back head; the door sheet is welded to the firebox side sheets and the crown is welded to the side sheets.

The firebox has five seamless-steel circulators supporting a brick arch. The vertical legs of the circulators enter the crown on the center line of the boiler and the horizontal legs enter the side sheets in locations sloping from back to front. The superheater is the Type AS with 138 units of the sine-wave type. Water is fed by means of a Sellers Type E injector on the left side and a Hancock Type 7-A-2 turbo feedwater heater on the right side, each of 13,000 gal. per hour capacity. The railroad company's standard grates, with 15 per cent air openings, are used and coal is fed by a Standard HT stoker.

While this locomotive consists of front and rear engines, it is not of the articulated type. This simplifies the steam and exhaust piping to the extent of eliminating ball joints. The steam pipes are designed to be free of restriction as to capacity. The dry pipe to the header is 10½ in. diameter inside with 9½ in. pipes inside the smokebox from the multiple throttle to a tee in each of the outside steam pipes, which are 7 in. These pipes, located longitudinally underneath the boiler, connects the manifolds at the cylinders, which serve the steam chests containing the poppet valves. Expansion joints are located in the pipes between the manifolds. The exhaust from the front cylinders passes through ports in the saddle to the front part of the double exhaust nozzle and companion ports in the front cylinder saddle receive the exhaust steam from a central exhaust line from the rear cylinders and transmit it to the rear exhaust nozzle. From there the steam passes out through a double stack with two 19-in. openings. The stack is welded to the smokebox. The feedwater heater takes exhaust steam from the rear engine unit.

The front end arrangement is of Pennsylvania standard design and is similar to that of the Class S1 locomotive No. 6100.

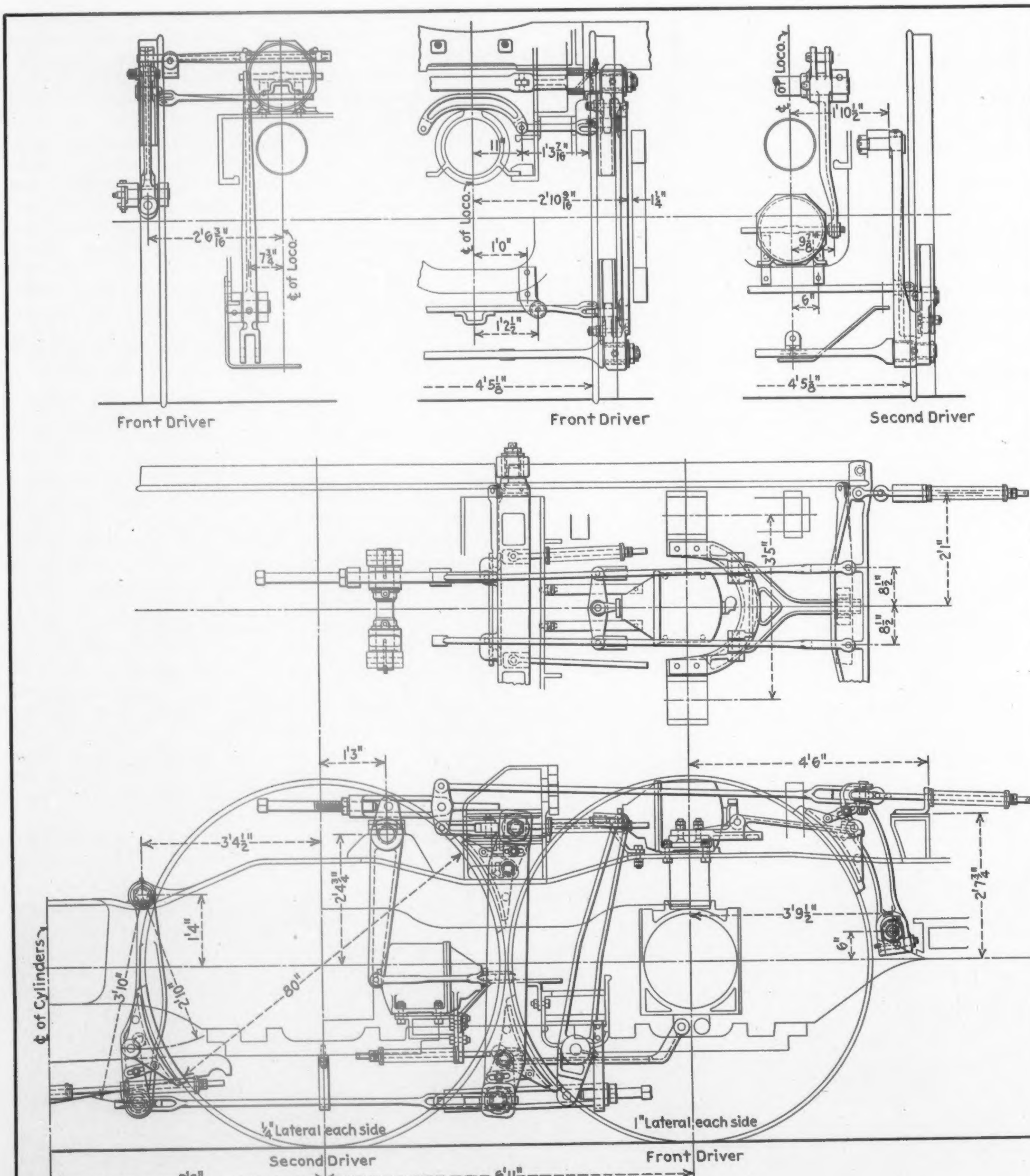
The Running Gear

The engine bed is a steel casting supplied by General Steel Castings Corporation which embraces the four cylinders, back heads, cross members, spring equalizer supports, brake-hanger brackets and various other attachments, all cast integral. The leading and trailing truck frames are also steel castings. The boiler is rigidly secured to the front cylinder saddle. At the rear cylinders and at the firebox lubricated sliding shoes take care of expansion and contraction.

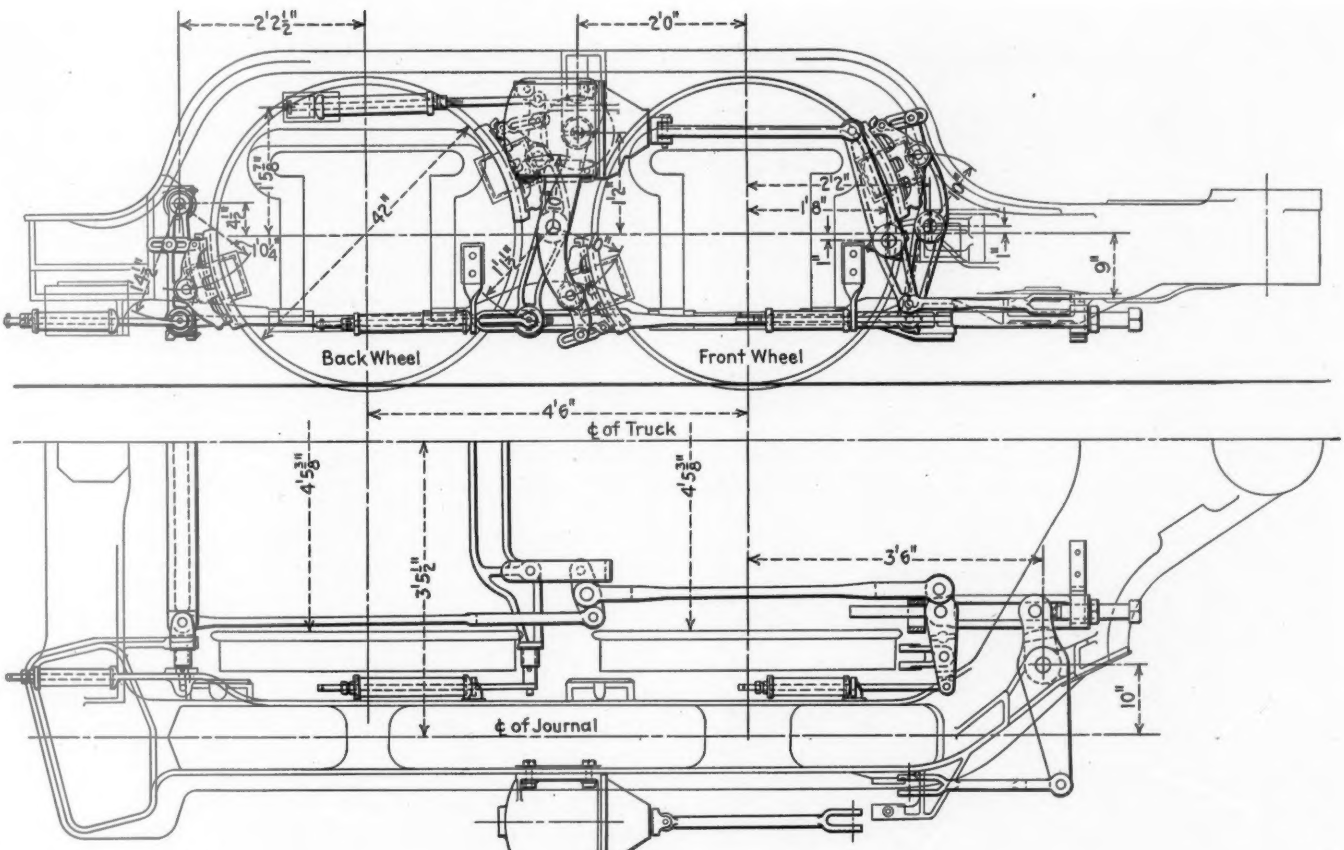
The driving wheels are the Baldwin disc type with flanged tires on all drivers. The Alco lateral motion device, allowing 2 in. total lateral play is used on the first and third pairs of drivers. The resistance against lateral movement at No. 1 wheel is 17 per cent and at No. 3 wheel 10 per cent. The wheels are mounted on open-hearth carbon-steel axles, hollow bored. Timken roller bearings are used on all engine and trailing truck and driving wheels.

The driving axles measure 11½ in. in diameter at the roller seat.

The spring rigging is a continuous equalization system for each side of the locomotive from No. 1 driver through the trailer truck. The spring hangers have ball seats on the end clips and roller pins at the lower ends. A coil spring snubber is used back of the rear trailer wheels.



The driver brake arrangement involved some new design problems



This design of trailing truck brake made possible a reduction in wheel center distance

In the design of the revolving and reciprocating parts weight reduction was a major consideration. To this end the pistons, crosshead forgings and the main and side rods are of Timken light-weight design and high-dynamic steel. Timken roller bearings are also installed on the crank pins and crosshead pins. The piston rods are hollow-forged, 4½ in. diameter. The crossheads are the Pennsylvania underhung design operating in multiple-ledge guides. The crank pins are Timken steel with hollow bored main pins. The left-hand cranks lead, in accordance with Pennsylvania practice.

Some indication of the influence of the small cylinder size on the design of reciprocating parts may be seen in the fact that these parts weigh only 1,992 lb. for one side of the locomotive—1,041 lb. for the front unit and 951 lb. for the rear unit. The weight difference between the front and back units is accounted for principally by a difference in piston-rod length.

The main crank-pin arrangement is the first roller-bearing application made to a four-coupled engine. This application differs from previous crank-pin applications in that separate bearings are used under the main and side rods. The main crack pin assembly is so designed that the rods may be removed without disturbing the assembly of the bearings on the crank pins. All enclosures on both main and front crank-pin assemblies are held in place by means of snap rings, thereby eliminating the use of cap screws or bolts. Both main and side rods are mounted on the bearing cups, or outer races and the lateral rod clearance totaling ⅛ in., together with the normal clearance between rod bores and bearing cups, allows for adjustment to the 2-in. total lateral of the first and third drivers. The lateral at the second and fourth drivers is ¼ in. in each direction, or a total of ½ in.

The arrangement of the driving-wheel roller bearings involves the use of a single row of rollers at each end of the housing. Special lugs are cast on the bottom of these housings to keep the movement of the braking parts in proper relation to the lateral movement of the wheels and axles.

The frame shoes on the driver application are the bronze insert type by means of which the fore and aft clearance of the housing within the pedestals may be adjusted by shimming.

The leading engine truck is the constant-resistance type with outside journals and roller bearings and the trailing truck is the Delta type, also equipped with roller bearings. Both trucks have heat-treated rolled-steel wheels 36 in. diameter on the front truck and 42 in. on the rear truck.

An interesting feature of the trailer truck is the reduction of 10 in. in wheel centers as a result of the clasp-brake arrangement described elsewhere. This, together with alloy castings permitting thinner sections, resulted in a truck weighing only 30,784 lb. Both trucks were furnished by General Steel Castings Corporation. The Franklin booster is applied to the rear truck of one locomotive and the other locomotive is designed for such application.

Brake Equipment

In the design of the foundation brake rigging for this locomotive, it was necessary to use clasp-brake rigging on all units in order to avoid excessive brake-shoe pressures per square inch of shoe surface.

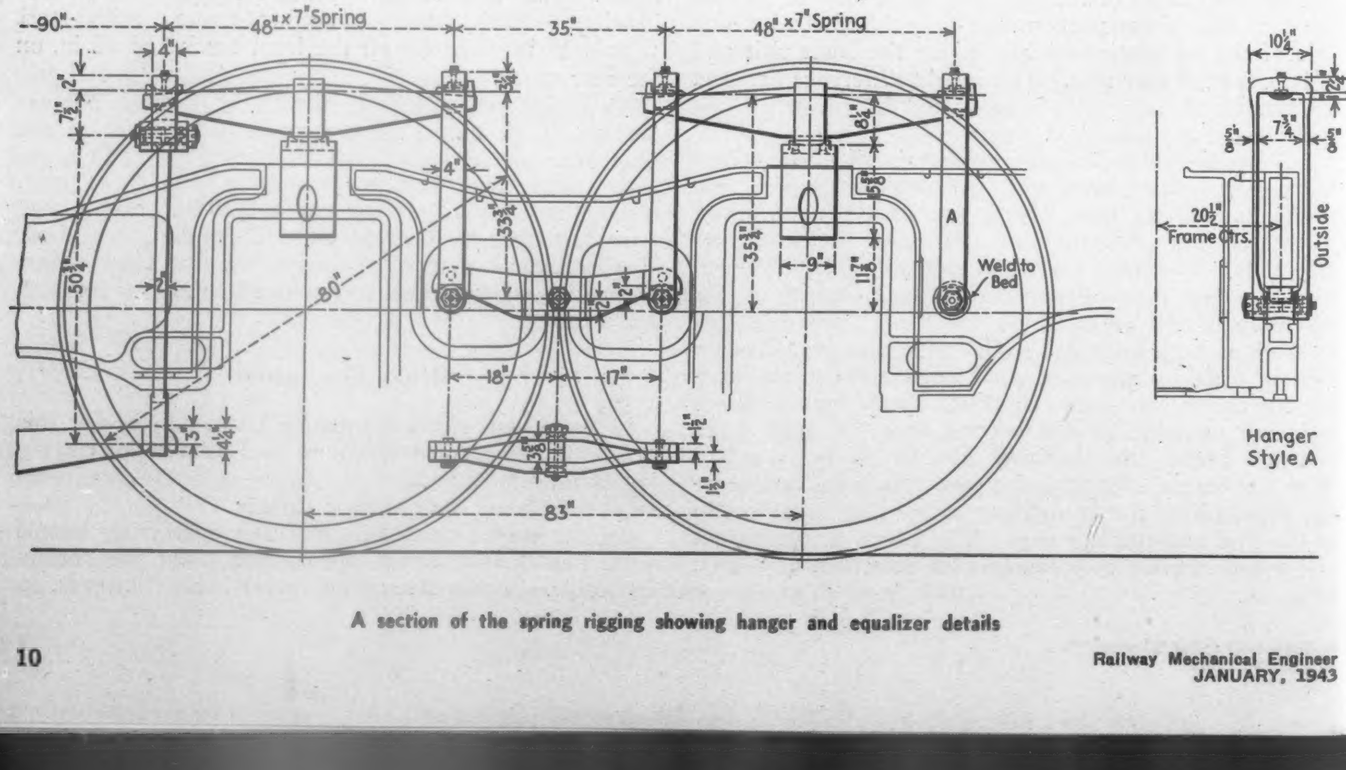
On the engine truck this was a comparatively simple matter, as a conventional type of clasp brake was readily applicable. In the case of the driver brake, however, so

Partial List of Material and Equipment on the Pennsylvania T-1 Class Locomotive

Locomotive bed with cylinders; engine and trailer trucks; trailer-truck centering device	General Steel Castings Corp., Eddystone, Pa.
Engine-truck and trailer-truck wheels; driving tires; trailer springs (one engine); trailer truck springs; driving-wheel centers	Standard Steel Works Division of the Baldwin Locomotive Works, Eddystone, Pa.
Driving-box roller bearings; engine and trailer-box roller bearings	The Timken Roller Bearing Co., Canton, Ohio.
Springs—driving and engine truck	American Locomotive Co., Railway Steel Spring Div., New York.
Brake shoes	American Brake Shoe & Foundry Co., New York.
Driver and truck brake; locomotive and tender brake equipment	American Brake Div., Westinghouse Air Brake Co., Wilmerding, Pa.
Train-signal equipment	Westinghouse Air Brake Co., Wilmerding, Pa.
Pistons; piston rods; crosshead; connecting rods; crank pins	The Timken Roller Bearing Co., Canton, Ohio.
Sectional piston rings	Locomotive Finished Material Co., Atchison, Kans.
Piston rod packing	U. S. Metallic Packing Co., Philadelphia, Pa.
Safety valves	Coale Muffler & Safety Valve Co., Baltimore, Md.
Operating valve and relay valve for air whistle	Viloco Railway Equipment Co., Chicago.
Poppett valve gear; power reverse gear	Franklin Railway Supply Co., Inc., New York.
Cylinder cocks; blow-off cocks	The Okadee Company, Chicago.
Boiler steel	Lukens Steel Co., Coatesville, Pa.
Tubes and flues; steam pipes	National Tube Co., Pittsburgh, Pa.
Flexible staybolts	Flannery Bolt Co., Bridgeville, Pa.
Mechanical lubricators; lubricator check valve; oil distributors	Nathan Manufacturing Co., New York.
Booster (one locomotive)	Franklin Railway Supply Co., Inc., New York.
Booster control valve	Nathan Manufacturing Co., New York.
Alemite fittings—tender and engine	The Prime Mfg. Co., Milwaukee, Wis.
Booster steam- and exhaust-pipe lagging	Johns-Manville Sales Corp., New York.
Automatic lubricator manifold drains	The Okadee Company, Chicago.
Security circulators; brick arrangement for circulators	American Arch Co., Inc., New York.
Superheater	The Superheater Company, New York.
Multiple throttle	American Throttle Co., New York.
Steam-pipe covering	Union Asbestos & Rubber Co., Chicago.
Turbo feedwater heater	Manning, Maxwell & Moore, Inc., Locomotive Equipment Division, Bridgeport, Conn.
Injectors	Wm. Sellers & Co., Inc., Philadelphia, Pa.
Stoker	Standard Stoker Co., Inc., New York.
Fire door	The Standard Locomotive Equipment Company, Toledo, Ohio.
Air whistle	Leslie Co., Lyndhurst, N. J.
Sanders	Graham-White Sander Corp., Roanoke, Va.
Headlight and generator	The Pyle-National Company, Chicago.
Bell ringer	Railway Service & Supply Corp., Indianapolis, Ind.
Cab window sash	The Adams & Westlake Co., Elkhart, Ind.
Clear vision cab window	The Prime Mfg. Co., Milwaukee, Wis.
Cab doors	The Morton Mfg. Co., Chicago.
Steel sheet for cab apron	Alan Wood Steel Co., Conshohocken, Pa.
Cab seat cushions	Dunlop Tire & Rubber Corp., Buffalo, N. Y.
Cab signals; train control	Union Switch & Signal Co., Swissvale, Pa.
Flexible connections between engine and tender; steam-heat connections	Barco Manufacturing Co., Chicago.
Tender: Frames	General Steel Castings Corp., Eddystone, Pa.
Tank steel	Carnegie-Illinois Steel Corp., Pittsburgh, Pa. Jos. T. Ryerson, Inc., Chicago.
Roller bearings	The Timken Roller Bearing Co., Canton, Ohio.
Coupler; coupler carrier; coupler release rigging; coupler yoke	National Malleable & Steel Castings Co., Cleveland, Ohio.
Draft gear	Waugh Equipment Co., New York.
Steam-heat connections	Vapor Car Heating Co., Inc., New York.

little space had been provided between the first and second, and third and fourth pairs of drivers that there was practically no clearance between treads of adjacent wheels at these points, and no room between adjacent wheel treads and rail for the two sets of heads and shoes usually located in this space on conventional clasp brake designs. Accordingly, it became necessary, at each of these close points to locate one head and shoe above the center line of the wheel and the adjacent head and shoe of the adjoining wheel below the center lines, both shoes being actuated by a single four-point lever, the middle portion of which cleared the outside faces of the drivers. Each of these levers was moved, during brake applications, by two brake beams, one at the top and the other at the bottom, which were then forced in opposite directions by two different sets of brake cylinders. The levers, shoes, heads, and beams were all supported by frame wearing plates above and below the upper brake beam.

Further driver brake complications were necessary be-



A section of the spring rigging showing hanger and equalizer details

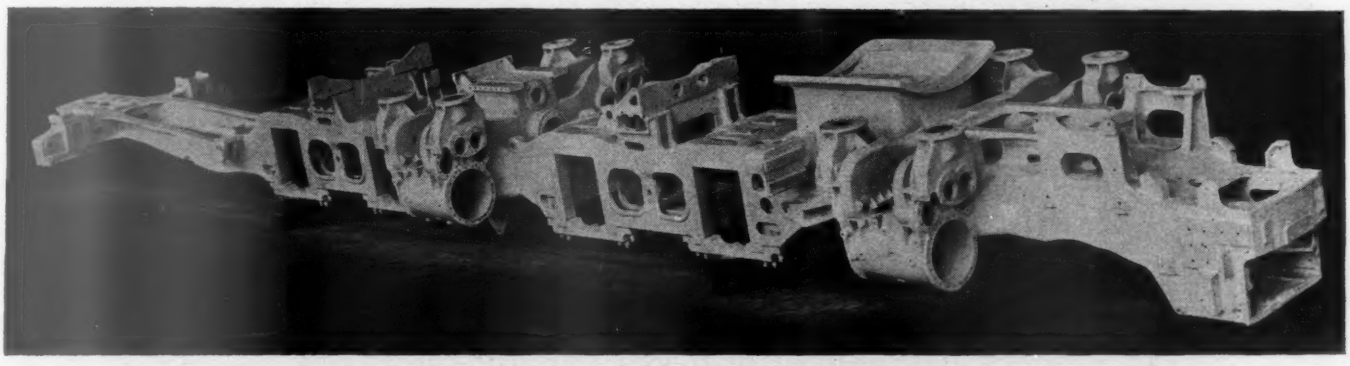
cause of a 1-in. lateral movement, each side of the center line, in the first and third pairs of drivers. This required guiding members hinged at the top and bottom of the bearing housings to insure that the brake shoes followed the wheels in their lateral movements. It also required the use of a heavy pull rod with a swiveling jaw; and double-swing suspension of the transmitting and hanger levers at the drivers having lateral movement. This last provision introduced additional special construction in the top and bottom bearings of the four-point levers, as it became necessary to mount the beam journals in blocks having flat vertical faces but rounded top and bottom surfaces, thus allowing swing in a vertical plane, but not in a horizontal plane.

The trailer clasp brake arrangement was somewhat simpler, owing to greater clearance between the adjacent wheels. It was still necessary to hang one of the adjacent head and shoe combinations above the center, but it was then possible to apply the scissors type of twin lever, in which pressure at one end of the member applies equal pressure to both shoes.

The locomotive and tender brake equipment is Westinghouse HSC of the same type as on the S-1 locomotive except that it does not have electro-pneumatic speed control. Train air is supplied by two 8½-in. cross-compound compressors located at the front end of the frame behind the intercooler. The brake equipment is designed for 95 lb. emergency application. The braking power at 50 lb. cylinder pressure is 60 per cent on both engine trucks, 80 per cent on drivers and 120 per cent of empty tender weight. The train signal equipment is Westinghouse Type C.

The mechanical lubrication system consists of four Nathan DV-7 lubricators. Two of these are 16-feed units, one each for the poppet valves of front and rear engines. Eight feeds of each unit are for inlet valve stems and the other eight for exhaust valve stems. The

The front end of the tender



The bed, for both front and rear engines, is a single casting

internal mechanisms of gear and cam boxes operate in oil baths.

The other two mechanical units serve the cylinders, guides, booster (on the locomotive so equipped), stoker, exhaust-pipe expansion joint, sliding boiler supports, journal housing shoes and throttle stem. Alemite fittings for grease, in numerous locations on the chassis, complete the lubrication system.

The Tender

One of the railroad company's requirements for these locomotives was that they should be able to operate over the 713-mile territory between Harrisburg and Chicago with only one fuel stop. This is responsible for the unusually large fuel capacity of 41 tons. Water is taken from track pans while running by means of an air-operated water scoop so that the tender tank capacity need be only 19,500 gallons.

The rectangular U tank is mounted on a General Steel Castings Corporation cast-steel underframe in which provision is made for the stoker engine. The unusually large coal capacity necessitates the use of an exceptionally long stoker trough and conveyor screw.

The tender is carried on two General Steel Castings eight-wheel trucks. The trucks are equipped with Timken roller bearings.

Barco flexible connections are used between the engine and tender. Vapor steam-heat connectors are used at the rear of the tender. The tenders are equipped with National tight-lock couplers and Waugh draft gear.

Walter Henry Flynn

Chairman, Mechanical Division

Walter Henry Flynn

An outstanding railway mechanical department organizer and administrator

In 1941 the New York Central System expended $92,454,568 for the maintenance of equipment—a very considerable operation, even in these days of big business. For 15 years Walter H. Flynn has headed up this department with unusual success, having under his direction approximately 29,450 employees, who maintain and repair the 3,440 locomotives, 127,656 freight-train cars and 4,557 passenger-train cars.

That Mr. Flynn is also highly regarded by the mechanical department officers of the railroads of North America is evident from the fact that he is chairman of the Mechanical Division of the Association of American Railroads.

By what route did he reach these positions of trust and eminence, which reflect administrative ability of a high order? What sort of a man is he?

Started Railroading Early

Walter Henry Flynn was born in Buffalo, N. Y., June 24, 1877. He spent most of his early life in St. Thomas, Ont., where his father was stationed as a master mechanic of the Michigan Central. It is said that the ambition to become a railroad mechanical man "took hold of him when he was just a rosy-cheeked lad with a shock of dark curly hair, and all of 10 or 12 years of age." Old timers on the Michigan Central report that at about that time he took over the "supervision" of the engine tracks and coal dock and soon had the men thereabouts "eating out of his hand." They all "loved the 'little devil,' as he was affectionately called, in spite of the fact that hostlers, on some occasions, had embarrassing moments with 'the boss,' explaining such things as damaged pilots and brake beams, which were found later by the inspectors; but these mysterious happenings were never accounted for."

At School and College

When Walter completed his grammar and high school training in St. Thomas, and also incidentally, what the railroaders regarded as his "primary mechanical course" at the shops and engine terminal, he was well prepared by the fall of 1895 for entering the engineering department of Michigan State College at East Lansing. He specialized in mechanical engineering and was graduated in 1899 with the degree of B.S.

Michigan State is a land grant college and military training was compulsory during the first two or three years for all able-bodied students, unless excused for some good reason. Engineering students, with their heavy programs, including time-consuming shop and laboratory work, were generally not keen about continuing the military training beyond what was absolutely required; and at that, many of them did not put forth much effort to excel in that department. Walter took a real interest in it, however, and in his senior year was appointed a captain of one of the four companies which made up the battalion.

This, however, was not the only evidence of leadership ability demonstrated in his college days. He was manager of the football team in 1898. So far as scholarship is concerned, a college mate reports that he "was the same at college as he is now—very active and industrious." He was elected to membership in Tau Beta Pi, an engineering college honor society.

Railroad Career Briefly Sketched

In September, following his graduation, he was employed as a mechanical draftsman in the office of the master mechanic of the Cleveland, Lorain & Wheeling, now a part of the Baltimore & Ohio. A year later, September 1, 1900, he entered the service of the Michigan Central at Detroit, as a draftsman in the mechanical engineer's office. On March 1, 1902, he was made assistant general foreman at the Jackson, Mich., shops.

An associate of Mr. Flynn's at that time says that he "was always the first man on the job in the morning and the last man to leave at night—a trait which has followed him right up to the present day."

To those who may have had assignments for taking indicator cards on passenger locomotives in the early part of the present century, the following report from a colleague of Mr. Flynn may stimulate vivid recollections. "We had received an Atlantic type locomotive and the management was desirous of making a test and obtaining some indicator cards. It devolved on Mr. Flynn to construct the platform on the front end for the use of the men taking the cards. The locomotive was assigned to Train No. 23, the Pacific Express. West of Kalamazoo, where the conditions were rather ideal, but the curves numerous, the engineer really opened her up. The old upright Boyer speed recorder edged up to the post, which was 90 miles an hour on the old type. We were certainly going! (That speed was unusual in those days.) There was a lull between taking the cards and Mr. Flynn and I crawled down behind the protecting boards across the front end. He inquired as to what would happen if we unfortunately hit a cow; you can imagine my reply and the laughter that ensued, which was audible even above the exhaust of the locomotive."

On February 1, 1905, Mr. Flynn was promoted to general foreman at the Jackson shop. With an excellent foundation in both the designing and the maintaining of equipment, his early experience still remained to be rounded out with a third phase—mechanical operation—and on September 1, 1907, he was promoted to master mechanic, with headquarters at St. Thomas. He thus returned to his boyhood home and to the position formerly held by his father. On June 1, 1912, he was made superintendent motive power of the Michigan Central, with headquarters at Detroit. On April 16, 1925, he

was called to New York as superintendent motive power of the New York Central, Lines East. In September, 1926, he was made general superintendent motive power of the New York Central, and in January, 1927, was advanced to general superintendent motive power and rolling stock, which position he now holds.

The organization of the mechanical department on the New York Central differs from that on most railroads. It is made up of two divisions, the heads of which report to the executive vice-president. The equipment maintenance section is headed by Mr. Flynn; and the equipment engineering department by Paul W. Kiefer. Naturally, certain important aspects of the work are intimately related, or interrelated, and must be acted upon jointly. An attitude of constructive and wholehearted co-operation is thus essential on the part of the two leaders and their respective staffs. Needless to say such a spirit does exist.

The equipment maintenance division also overlaps the operating department to the extent that the locomotive firemen and engineers are trained and supervised, so far as craftsmanship is concerned, by the mechanical department.

This, in brief, sketches Mr. Flynn's early training and railroad career. Now for a more intimate picture of the man, his accomplishments, and the way he works.

Thoroughness Stands Out Prominently

As one studies him through the eyes of his associates, a certain quality stands out prominently, i.e., his thoroughness. Says one of them, "His thoroughness of handling any subject has made him so well informed on all subjects connected with the mechanical department of the railroads that you can well class his opinion as authority on such matters. His curiosity has always driven him to ferret out the whys and wherefores of any subject which came to his notice and, I will say, not very many escaped his eye. He was never satisfied until the final solution was found. He has the gift of weighing carefully any decision he has to make and does not allow anyone to influence him in making it. He will take the time to find out for himself and then act."

Another associate—one who has known him since his college days—says: "I marvel at his ability to master detail. Mr. Flynn does not rely on his subordinates with regard to any detail of his locomotives and cars, or the numerous rules and regulations governing their maintenance."

Says still another: "His progress, though of moderate momentum and not conspicuously perceptible from day to day, resulted in the end in that sure attainment that is the cumulative result of diligent and faithful attention to the tasks of each passing day."

A Good Operating Man

Possibly when still a lad he may have sensed the fact that the real objective of a railroad organization is to furnish transportation, and that the mechanical department is only one means toward that end. At any rate, the man who was superintendent at St. Thomas when Mr. Flynn became master mechanic and who was associated with him for many years thereafter, speaks of him as "an operating man of great ability. He was at all times working to produce better mechanical performances and first-class operation. Very few men possess these joint abilities, so necessary for the successful operation and financial showing of any railroad property."

To support this statement the operating officer cites the following incident as typical:

"In 1911 we had placed before us a most difficult passenger operation; the meeting of a Twentieth Century operation between Detroit and New York on the basis of our pro-rated mileage from Detroit to Buffalo. We had to start with delays for customs and immigration between Detroit and Windsor, also Bridgeburg, Ont., and Black Rock, N. Y., frontiers—where delays were always met with—and also a fixed arbitrary of 13 minutes to run from Black Rock to Buffalo—four miles—over tracks of another railroad. With these handicaps before us, a problem was presented that looked almost impossible. We had a meeting one Sunday morning—superintendent, master mechanic, road foreman, trainmaster and five of our passenger engineers. I told the group what we were confronted with and stated it looked to me like a schedule of 102 minutes for 110 miles, Windsor to St. Thomas, and 113 minutes for 118 miles, St. Thomas to Bridgeburg, with from five to eight Pullman cars.

"There was a general shaking of heads, but after eight hours of effort a schedule was worked out on that basis. What always impressed me was the way the mechanical operation was worked out and the perfect understanding that was had by each person present that this operation was safe, practical and feasible; Walter Flynn's judgment was good, and later on, operating results confirmed it in every detail. The train was operated from the Old Station on the river and a back-up was made to the west end of the new tunnel under the river. Our division received the trains 15 to 25 minutes late every day at Windsor. We ran the train every night from Windsor to St. Thomas in 96 to 98 minutes, and into Buffalo for the first three months 99½ per cent on time. This, at that time, was the fastest scheduled train in the world. President Smith later almost broke our hearts by ordering 30 minutes more in the schedule of the 'Detroiter,' which we always considered had established a record that we could justly feel proud of.

"When Mr. Flynn was called to Detroit in 1912 he met the difficult problems he found and for the next 14 years he was responsible for a very satisfactory and successful mechanical operation, equal to any in the country on any railroad. We were in front ranks in starting running passenger engines through long distances—Detroit-Chicago—and the operations were very successful, thanks to Mr. Flynn's close attention. One could go on indefinitely giving instances to demonstrate his mechanical-operating ability."

Incidentally, as any experienced railroader knows, there are plenty of opportunities for interdepartmental misunderstandings and friction. The railroad suffers when different departments work at cross purposes. Maximum efficiency depends on a unity of purpose and harmonious striving to achieve a common objective. Mr. Flynn, according to his associates, has been unusually successful in "ironing out" rough spots. This has been accomplished, not by issuing orders or by disciplinary measures, but in a quiet, unobtrusive way and largely by the power of suggestion. He seems to have a special ability in inducing a friendly co-operative spirit to replace one of faultfinding and noncooperation.

A Labor Leader's Viewpoint

It is not surprising, in light of what has already been said, to learn that Mr. Flynn has been successful in dealing with the most difficult problem in railroad op-

eration—that of employee relations. This may possibly best be placed on record by quoting from a labor leader who was associated with him for many years.

"In the early days," says this leader, "questions between labor and management were handled in the hard-fisted manner; you sat across the table and told each other what you thought and did not draw your punches. I make mention of this, because I feel that the opportunity to size men up as to their feelings toward the worker were greater then, than now.

"Mr. Flynn is one who recognizes the necessity of labor to organize and act collectively and he encourages rather than discourages organization of employees. If you can picture in your mind a man with this principle, you can readily see that in his dealings where the worker is concerned, he is quite apt to look upon labor matters in a humane, fair and equitable way.

"During the years we dealt with each other we were confronted with just about any kind of a situation that would arise involving labor and management. In every instance I found Mr. Flynn ready and willing to discuss the situation in an endeavor to reach an amicable settlement. This has been a valuable asset to both the company and the workers, for the attitude of the immediate supervision quite generally patterns from the head of the department."

More About Employee Relations

Mr. Flynn was superintendent of motive power and equipment of the Michigan Central during the shop crafts strike in 1922. An observer, close to him at that time, comments on the fact that he had the situation in hand better than many other roads, because he knew the Michigan Central personnel so well. "I attributed the results very largely," says this observer, "to the confidence which the supervision—foremen and up—had in the higher bosses. The foremen, as well, evidently were close to the men—all of which spoke well to me of proper organization. As you know, this can only be developed by steady and consistent treatment."

When Mr. Flynn went to New York in 1925 he found many serious complications growing out of the strike settlement. The System succeeded, however, in "building up sound relations with the committees and working out solutions to an extent which could not have been accomplished if he (Mr. Flynn) had not devoted so much of his time and energies to proper relations between the immediate supervision and the forces."

The relatively small number of grievances which have to be appealed from the point of origin to the higher motive power officials on the New York Central is the best evidence of satisfactory relations between supervision and the employee groups. "This," says an associate, "could not have been the case unless the employees had confidence in the man at the top."

A sidelight on Mr. Flynn's interest in the employees' welfare is his association with the Railroad Y. M. C. A., most of whose members are locomotive engineers and firemen, trainmen, shopmen and members of the clerical staff. He served as the president of the Railroad Y. M. C. A. at West Detroit for many years, taking a most active interest in its operations. "The outstanding impression I have of him," says one of the traveling executives of the Railroad Y. M. C. A., whose territory included the Michigan Central, "is his cheery disposi-

When Walter Flynn was made master mechanic of the Michigan Central in 1907

Bottom row, left to right: A. Link, master mechanic, W. Detroit; W. H. Flynn, master mechanic, St. Thomas.—Second row: George E. Parks, master mechanic, Jackson; D. R. MacBain, assistant superintendent motive power; E. D. Bronner, superintendent motive power; J. A. McRae, mechanical engineer.—Center, between second and top rows: Tom J. Hennessey, master mechanic, W. Bay City.—Top row: W. H. Corbett, road foreman, Jackson; Dave Meadows, assistant master mechanic, St. Thomas; E. Russell Webb, master mechanic, Michigan City; M. J. McAndrews, road foreman, St. Thomas; J. F. Jennings, road foreman, Detroit; C. McCormick, chief clerk to superintendent motive power.

tion, his readiness to give practical suggestions about the work of the Railroad Y. M. C. A., and his open-door policy that made it possible for me to see him whenever it seemed desirable."

As to Discipline

While Walter Flynn is a man of extreme fairness, at times leaning over backwards to be fair and equitable in his dealings with others, it must not be assumed that he is soft and uncertain in discipline. One of the kindliest men, he is at the same time a firm disciplinarian.

Sloppy work or lamentable behavior never go unnoticed by him; on the other hand, commendable deeds are treated in the same way. Both types of comment, however, are always meted out in private. "I have known cases," says one of his associates, "where men have made mistakes and admitted their fault and have been given kindly advice and correction, but woe betide the man who would lie deliberately to get out of difficulty, as that was one failing that Mr. Flynn would never tolerate and he has an uncanny faculty of sorting out truth from fiction. He is a keen observer and appears to sense when some job that might not rate 100 per cent is being 'covered.' I have heard some mechanics remark, 'Stick it right out in the open; that is the only way the Boss might miss it.'"

A humorous incident happened in a certain shop where the local official heard at a late hour that the "Boss" would be in town. Strenuous efforts were made to clean the shop; all material was placed outside the white line for safety and the shop was swept clean; a real camouflage job was done by sweeping the dirt well back under the benches. The "Boss" arrived and after passing the first bench requested that they see what could be found under the benches. Needless to say, there was plenty of material and sweepings and the shops were not allowed to let up until all the benches had a thorough cleaning both inside and out.

Another incident is told of a fire practice at a certain shop where they always put on a real show for the "Boss"; it was always done in split second time. On one occasion the stage was all set and the men advised that a certain station would be signaled by the fire whistle. Mr. Flynn was apparently wise and at the appointed time pulled another station—the boys answered the call, but they had started in the wrong direction and had to retrace their steps, much to the embarrassment of the fire chief, who, it is said, profited by the experience.

Technical Achievements

Incidental reference has already been made to Mr. Flynn's activity in extending the length of locomotive passenger runs on the Michigan Central. He has played a most important part in the campaign for greater utilization of locomotives in all types of service, and since 1934 has served as a member of the Joint Committee of the A. A. R. on Utilization of Locomotives and Conservation of Fuel.

Comparable figures for locomotive utilization are not available on the New York Central prior to 1930. It is instructive, however, to compare the first eight months of that year with the corresponding period in 1942. The locomotives in service, including freight, passenger and switch engines, decreased from 5,039 to 3,451, or a reduction of 31.5 per cent. During the same period the reduction in locomotive-miles was only 1.7 per cent. Passenger car-miles were substantially the same, but the freight car-miles increased over 22 per cent.

In August, 1930, the locomotive-miles per day per serviceable freight locomotive (including stored locomotives) was 68.5, and in August, 1942, this had increased to 121.6 or 77.5 per cent. In the same period the gross ton-miles per freight locomotive-mile increased 15.3 per cent.

Closely associated with the greater utilization of locomotives has been the stepping up of standards of maintenance of both locomotives and cars. This has involved the centralization and rehabilitation of shop and repair facilities, and radical changes in the methods of organization and operation.

The introduction of shop scheduling systems has facilitated the making of locomotive repairs, increasing the shop output per pit per month and reducing the number of locomotives out of service for repairs. The shopping of freight cars by classes, rather than on a run-of-mine basis, and the introduction of the progressive system of rebuilding and making repairs has speeded up production and reduced out-of-service time. Similar methods, so far as practicable, have been applied to the repair and rebuilding of passenger cars.

In 1927, fifteen years ago, when Mr. Flynn was appointed to his present position, the New York Central System had a total of 19 shops, which were classified as locomotive repair shops. Several of these, however, were not what might be called major shops. As a result of changes which have been made from time to time, the general repair of locomotives has been consolidated into six principal shops at central locations in the several operating districts.

In the same manner, the heavy car repair work which in 1927 was performed in 23 miscellaneous shops has been consolidated into four major shops.

During the same period there has also been a reduction in the number of engine terminals on the system from 203 to 150.

Training Men—Young and Old

Mr. Flynn has always taken a sympathetic interest in the training of the younger men in his department. Particularly on the Michigan Central he visited the apprentice schools periodically, giving encouragement to the boys and their instructors. While he may not have been able to do this on the same scale, as he assumed larger responsibilities on the System, yet working through others he has constantly sought to improve the training methods, and to help the young men to develop themselves to the full extent of their abilities. Few mechanical officers felt so keenly the necessity for slowing down the training methods during the "thirties."

It is significant, also, that today hundreds of the gang leaders, foremen and supervisors are receiveing special training in foremanship and leadership.

Arbitration Committee

Probably one of the most important, and at the same time the most difficult assignments in the Mechanical Division of the Association of American Railroads is membership on its Arbitration Committee. It is the duty of that committee to settle disputes arising between the members under the Rules of Interchange; to recommend at each convention such changes, suggestions, amendments or additions to the Rules of Interchange as may be thought advisable. Mr. Flynn became a member of that committee in 1931 and succeeded to the chairmanship in 1934; he was elected chairman of the Mechanical Division in 1940.

One of the members of the Arbitration Committee

says that after he became chairman, "it soon became evident that his many years of experience with operating rules, in dealing with men and mechanical problems, his keen analytical mind and rare common sense, coupled with a fine sense of fairness, eminently qualified him for the work. He never jumped at conclusions. He always wanted to hear both sides of an argument, to which he would listen with great patience. After having done so, however, he intuitively and with little concern, reached a just and proper decision."

Another close observer of the operations of the Arbitration Committee refers to his "very tactful handling" and points out that "his courteous conduct at all times endears him not only to all the mechanical officers with whom he comes in contact, but also the shippers, tank car operators and private lines representatives."

Relations with Supply Representatives

Walter Flynn is popular among railway supply representatives and manufacturers, as he is with railroad men. "From a commercial standpoint," reports a friend in the supply field, "he gives no more consideration to a friend when it comes to something we might wish to interest him in, or sell him, than he does to anyone whom he might have seen for the first time. It is strictly business with him and the New York Central comes first."

Says another railway supply representatve: "Mr. Flynn is one of the hardest working men that I know, and yet a visitor in his office never feels that he is being hurried or that his call is an intrusion, or is interfering with his work. Yet I have known him, after giving time to visitors from his very busy day, to remain after hours to complete work which he felt should be done before calling it a day."

Hobbies

In a strict sense Mr. Flynn has no hobbies. His work and his family occupy him entirely and he loves them both. He does play a little golf—but not much. "Even in the game of golf," says a friend, "he is as intense as he is at his desk or on the road."

His hobby is in truth his vocation. It has even been suggested that if he had time for a hobby it would be operating a fully equipped scale model of the entire New York Central System. On rare occasions he manages to slip off to his camp in the White Mountains for a little rest and relaxation.

Summing Up

Industrial leaders, as well as railroad officers, are exerting every effort to speed up production in the war emergency . All along the line, from the executives down through the foremen and supervisors and men in the ranks, efforts are being made to do a more effective and more efficient job.

Railroad mechanical department officers, with diversified forces spread out in large and small groups over great areas, often embracing several states, are confronted with an unusually difficult task. The industrial executive, with highly concentrated forces in a single plant, can well afford to study the successful railroad mechanical leaders whose skill must indeed be magnified to cope with the complicated and difficult problems with which they are confronted.

New York Central executives have the reputation of spending much time on the road—out on the firing line, so to speak—and Mr. Flynn is no exception to that practice. Thoroughly versed in the details of mechanical department equipment and practices, he also possesses those qualities which make for leadership—the ability to select and develop capable subordinates and to inspire them and the men under them, down into the very ranks, with a spirit of loyalty and co-operation. Modest and unassuming, with an aversion to publicity, in a quiet but effective way he exerts a powerful influence, which is clearly reflected in the high standards of equipment maintenance and operation on the New York Central.

New York Central committee which judged fuel conservation posters in an employees' competition in the Spring of 1930

Left to right: C. W. Y. Currie, publicity manager; J. V. Neubert, chief engineer, maintenance of way; Walter H. Flynn, general superintendent motive power and rolling stock; D. W. Dinan, general manager; F. H. Hardin, assistant to president; A. A. Raymond, superintendent of fuel and locomotive performance.

Railroads' Use of

Flame Hardening Processes*

Part II

By F. C. Hasse†

Carbon content determines possibility of successful applications—Numerous locomotive and car parts now flame-hardened—Experiments are continuing to extend usefulness of the process

IN general, any steel that can be hardened by simple heating and quenching with water or air can be flame-hardened. The degree to which plain carbon steels can be quench-hardened is dependent upon the carbon content of the steel. To obtain reasonable increase in hardness, the steel should contain at least 0.40 per cent carbon. As the carbon content increases, the hardness obtainable increases. The general range for plain carbon steel is from 0.35 to 0.70 per cent carbon. Steels with greater carbon percentage can be flame-hardened, but greater care is required in their treatment to avoid checking. To provide a less drastic quench, the quenching medium generally used for the steels with higher carbon content is air or an air-water mist.

The most desirable steels for flame-hardening are carbon or low-alloy steels. These usually harden to a good

Locomotive radial buffer castings are hardened with two 30-flame heads

degree, and, except for certain types, will usually withstand heating and quenching without checking or cracking. Locomotive axle steel has been found satisfactory. It is suitable for forging and shaping and is readily machinable, thus serving as a satisfactory material for many locomotive and car parts.

Tables are available showing in detail the various steels that can be successfully flame-hardened, together with their complete analysis and hardness results.

A great many grades of cast iron, both with and without special alloying elements, have been found to respond quite satisfactorily to the flame-hardening process. Cast iron is basically a steel matrix in which are embedded numerous particles of free graphitic carbon. In the flame-hardening process this matrix is hardened, the graphite inclusions playing a minor part and remaining practically intact in the hardened material. It is the combined carbon content of the cast iron that controls the susceptibility of the material to flame-hardening and quenching. Considering the cast-iron matrix in the light of what has been stated regarding the carbon content of steels to be flame-hardened, it must follow that the combined carbon content of a cast iron to be treated by this method must be somewhere in the range of 0.40 to 0.85 per cent.

Available evidence on the subject points to the fact that both plain and alloy cast iron can be successfully flame-hardened, with little difference in final results, by giving proper consideration to the effect of the alloying elements present. The importance of the alloying elements lies in their effect upon the physical properties of the material rather than upon the flame-hardening process. The inclusion of the usual small amount of special alloying elements, such as chromium, nickel, molybdenum, or vanadium, has little important effect upon the hardening of the material by the flame-hardening process. As in steel, these elements tend to lower the transformation or critical temperature and will allow hardening to be accomplished at a lower temperature. On the other hand, certain of the carbide-stabilizing elements will necessitate a higher temperature for complete solution before quenching.

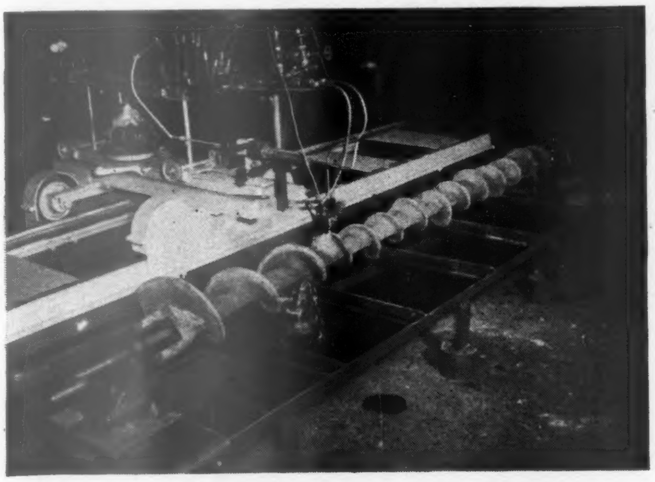
Cast iron has a large field of usefulness as an engineering material; and when chilled, it has a high resistance to wear. Much higher machining costs, however, ordinarily prevent the use of chilled castings where machined surfaces are required and where dimensional accuracy is important. Here flame-hardening is particularly useful since the softer cast irons which have not been chilled can be easily machined and then flame-hardened to produce the required hardness and wearing properties.

The flame-hardening of fully malleabilized cast iron cannot be considered as entirely successful. In this material, essentially all of the carbon present is in the graphitic form, the matrix being almost entirely carbide-free ferrite. The time element involved in flame-hardening is too short to allow a satisfactory reabsorption of the free carbon into the matrix to produce a uniformly hardened material. Fully malleableized iron may be given a pretreatment of a nature that will result in the absorption of

* Paper read before meeting of Southern and Southwestern Railway Club, Atlanta, Ga., September 17, 1942. (Part I of this paper appeared in the December, 1942, issue.)

† General manager, The Oxweld Railroad Service Company, Chicago.

a sufficient amount of combined carbon in the matrix to allow response to the flame-hardening treatment, but this treatment alters drastically the physical properties of the malleable iron. Some of the so-called pearlitic malleable



Stoker screws are rotated under two transversely moving flame-hardening heads; this is the spiral progressive method of hardening

irons that contain a sufficient amount of combined carbon have been found to respond with complete satisfaction to flame-hardening.

Necessary Surface Conditions

Since flame-hardening is only surface hardening and since only a comparatively thin layer is treated, it is of vital importance that the surface be in the proper condition to react successfully to the hardening. In the processes of forging, casting, normalizing, annealing, and in certain heat-treating processes, carbon may be extracted from the surface of the material, leaving a decarburized layer which will not harden, as this zone may be entirely lacking in carbon or the percentage of carbon reduced below the hardening range.

It is essential that decarburized surfaces be removed prior to the hardening operation. If they are not removed soft spots will occur in these zones. Decarburized metal can be taken off by machining or grinding, depending on which procedure is most suitable, convenient, or economical.

Pits and blowholes in the metal surface should be avoided. Occasionally there are instances where these defects may be covered by a thin layer of surface metal or scale which will fuse when the heat from the blowpipe is applied and the blowhole will be exposed. This is a defect in material and is not the fault of the operator although often he is blamed.

Seams and laps are material defects which have to be avoided. These flaws generally develop cracks during the quenching operation. Where either electric-arc or oxy-acetylene welding is used to reclaim a part before the machining and hardening, it is necessary to fuse the weld metal well and avoid laps. When the weld metal has just been melted and deposited without proper fusion with the base metal, a melting through will result when the hardening flame strikes the welded area.

Scale has a heat-retarding influence and where maximum hardness is desired, the surface should be thoroughly cleaned of scale before submitting it to the hardening operation. Scale can be readily removed by grinding, using a steel brush or oxy-acetylene flame-cleaning.

In general, do not expect to flame-harden with success these materials containing defects that make it impossible for them to be hardened by the more common methods.

After a flame-hardened part has been in service long enough to warrant removal for reclaiming, the remaining hardened areas can be softened or annealed by the usual furnace method, or the part or area can be heated with an oxy-acetylene flame sufficiently to draw the hardness so that the part can be machined. If, after flame-hardening, some re-forming is necessary, grinding is indicated. A soft, wet wheel of the type used for grinding high-carbon tool bits serves best because the harder wheels may develop sufficient heat at the surface of the metal to cause thermal cracks.

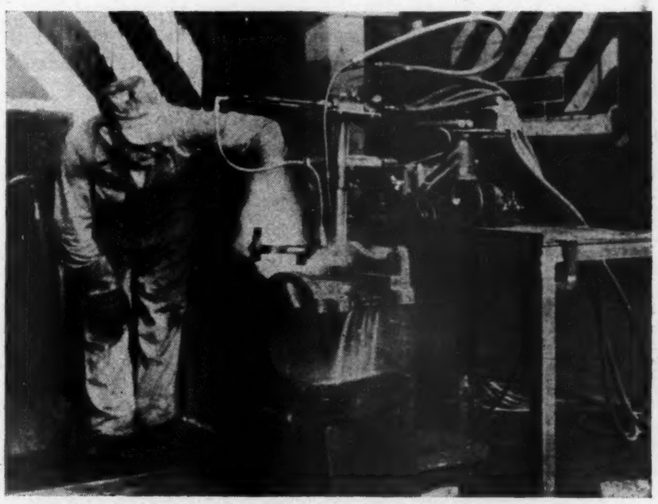
Estimating Costs

It has been found that to flame-harden one square inch of steel requires about one-quarter of a cubic foot each of oxygen and acetylene. This figure has often been found to be high but it will serve as a basis for general estimating purposes. Costs of oxygen and acetylene have been determined for most of the applications quoted and the manufacturers of the gases have data available on specific jobs and conditions. Labor cost is difficult to estimate because so much depends upon shop facilities and the degree of mechanization of the application.

Applications on the Railroads

The possible applications of flame-hardening in the railroad field are numerous. A few typical applications will serve to illustrate the tremendous possibilities of the process.

One of the first applications in a locomotive shop was in the flame-hardening of crosshead guides. Guides are



Surfaces on locomotive trailer truck boxes are flame-hardened from an original 210 Brinell to 530 Brinell

generally forged from old axles, and have an approximate carbon content of 0.45 to 0.50 per cent. This material is ideal for flame-hardening. The hardness before treating is generally 180 to 200 Brinell and after hardening is about 500 to 600 Brinell. The service life of flame-hardened guides has been found to be at least tripled. As an actual mileage test after 50,000 miles of freight service, an unhardened guide was worn 1/8 in. on the sides and top, whereas the flame-hardened guide on the other side of the same locomotive was worn only 0.007 in.

An operation that has received much attention lately, because of the shortage of strategic materials, is the flame-hardening of steel driving-box shoes. The shoes have been either cast or flame-cut from steel of sufficient carbon content for satisfactory flame-hardening. Steel

castings have beeen raised to 450 Brinell; and axle-steel shoes, to 600 Brinell.

Pedestal fits on driving boxes are being hardened successfully. The hardness has been raised on new cast-steel boxes from 210 Brinell before treatment to 530 after treatment. The service life of both driving boxes and shoes has been tripled by this treatment.

Rockers and rocker seats, when worn, are generally reclaimed by oxy-acetylene welding, using a 0.40 to 0.50 per cent carbon welding rod followed by flame-hardening. The service life is doubled and, in many instances, tripled by this procedure. The rockers, both the engine- and trailer-truck types, require about 10 min. hardening time.

Spring Parts

Spring saddles, when worn, are reclaimed by oxy-acetylene welding, using the high-carbon rod and flame-hardening. The hardness obtained is about 550 Brinell. The hardening time is approximately 4 min. It has been found that after 80,000 locomotive miles no wear is evident on the flame-hardened surfaces.

Flame-hardened spring equalizers, after 165,000 miles of service still show very little wear. The parts are generally made of low-carbon steel and must have the wearing edges built up with a high-carbon welding rod, after which a hardness of 600 Brinell is obtained by flame-hardening.

Other Typical Applications

A link and link block, each made of axle steel, were flame-hardened. After a year's service, the locomotive on which they were applied was returned to the shop for repairs. Upon inspection no wear on the parts was apparent and they were placed back in service again. Now, after 20 months of service no wear has been found. Blocks of this type can be flame-hardened to 600 Brinell in 3 min.; links can be hardened in 10 min.

Many chafing or radial buffer castings are made with a chilled surface. When service-worn they can be reclaimed by welding and flame-hardening. Castings so treated have run 100,000 miles with no wear detectable.

No mileage records for piston heads having flame-hardened ring grooves are yet available but this operation promises to exceed all predictions as an economical procedure. The ring grooves in cast-steel piston heads have been flame-hardened to 500 Brinell in approximately 30 min. New heads are expensive and when worn only slightly must be either scrapped or reclaimed.

Miscellaneous pins, such as crosshead wrist pins, knuckle pins, spring-hanger pins, and trailer center pins, can be flame-hardened economically. A crosshead wrist pin flame-hardened by the oxy-acetylene process has been run 110,000 miles with only 0.002-in. of wear.

Other locomotive parts that have been, and are being flame-hardened are: valve-pilot wheels, radius bar for combination lever, valve crosshead guides, valve crossheads, power reverse guides, piston and valve packing rings and stoker screws, racks, and gears.

Flame-Hardening in Car Shops

In car shops, draft keys, made of A. A. R. Class A, No. M-104 steel which has 0.40 to 0.50 per cent carbon, have been flame-hardened to 500 Brinell.

Flame-hardened passenger-car V-type and flat-belt-type pulley wheels used to drive motor-generators have given excellent service. These sheaves are generally made of cast iron or cast steel. A 10½-in. dia. V-type pulley with three grooves can be flame-hardened in 20 min.

A flat-belt cast-iron pulley wheel of 7½-in. dia. with an 8¾-in. face was flame-hardened in 6 min. The final hardness was 514 Brinell. With this type of pulley, the difficulty is not in breakage of the pulleys, but the loss of service and belt life when the crown of the wheel becomes worn. When flame-hardened, such a wheel was in service for three years on a passenger run between Chicago and the west coast. On this wheel only a 4-in. width at the crown had been hardened. At the end of the three years that area showed no wear but the adjacent soft areas were worn wavy from the slap of the belt. The procedure on this particular railroad has now been changed and the entire width of the pulley tread is hardened.

Flame hardening the face and two sides of crosshead guides triples their service life

Journal Boxes and Wedges

Wear tests on flame-hardened cast-iron journal boxes for passenger cars are at present in progress. Results are not yet definite but a substantial increase in life can be expected. The boxes were hardened, both on the equalizer seat and on the pedestal fit. The material used contained 0.69 per cent combined carbon and was hardened to 400 Brinell.

A wear test of flame-hardened journal-brass wedges has been in progress since June, 1939, on regular Pullman cars running between Chicago and New York. Results on this test will not be known until the test is completed. Wedges made from steel forgings, with sufficient carbon, can be hardened to 540 Brinell. This operation can readily be adapted to an automatic and continuous setup because of the large number of pieces to be flame-hardened.

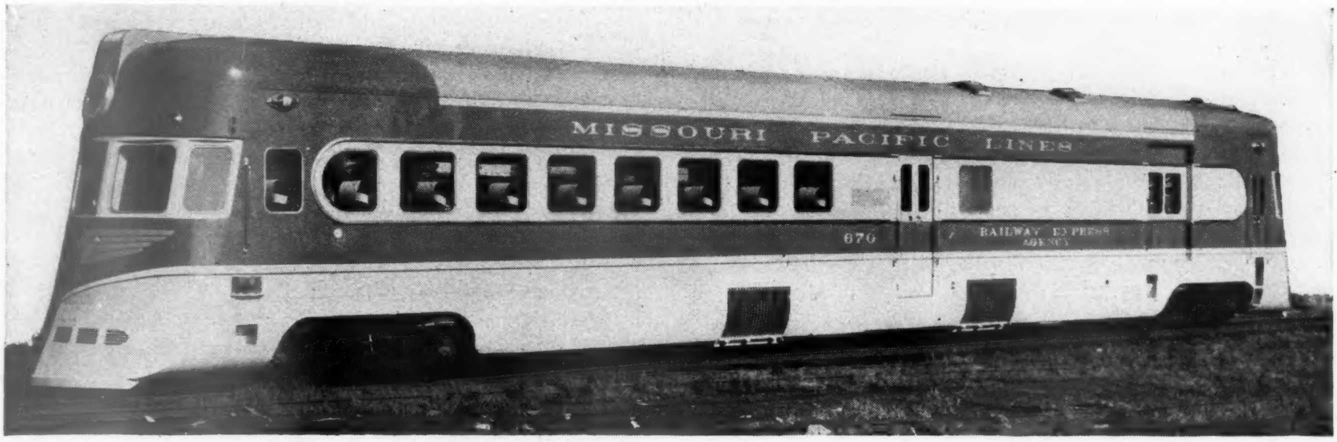
Other passenger- and freight-car parts which are flame-hardened are: equalizer-seat inserts for journal boxes, various wear plates made of carbon steel for riveting or welding to wearing surfaces, half pedestal castings, pedestal castings, draft-gear V-blocks, coupler carrying irons, coupler lock blocks, and side and center buffer stems.

Work Equipment

A number of interesting miscellaneous applications have been made on work equipment and on items for use in a railroad shop and on parts for the right of way.

Several frogs have been flame-hardened and are now in service for test. The frogs were fabricated from 85-lb.

(Continued on page 24)



Missouri Pacific motor car with power plants under the floor

Missouri Pacific Motorailer

Car delivered by American Car and Foundry Company renders connecting service for Missouri River "Eagles"—Seats 34 passengers and has baggage compartment—Two Waukesha oil-engine-generator sets mounted under the car body

A DOUBLE-end Motorailer has recently been delivered to the Missouri Pacific by the American Car and Foundry Company. This car, which is designed to develop a maximum speed of 70 miles an hour, will operate between Lincoln, Neb., and Union where it will make connections with the Missouri River "Eagle" trains running into and out of Omaha, Neb. The run is 47.7 miles long in each direction, and the car will make two round trips per day. It will be maintained at the Lincoln enginehouse.

The car is arranged with a center vestibule, a baggage compartment at one end to carry 10,000 lb., and a passenger compartment at the other end seating thirty-four.

Looking into the operator's compartment

Interior finish and trim in the passenger compartment and the exterior color scheme both match the Eagle trains, the predominant colors being blue and gray. The passenger compartment is air conditioned.

Power is supplied by two 210-hp. underbody-mounted Waukesha spark-ignition oil engines through Twin Disc clutches and torque converters to geared drive axles, each engine driving at one truck. The engines are capable of accelerating the car to its top speed of 70 m. p. h. in 3.5 min. over a distance of 2.6 miles on level tangent track.

The vestibule is built with open-step wells. The lower step revolves through 90 deg. and carries a section of skirt so that in the closed, or up, position of the step the skirt line is continuous.

The seats have individual reclining backs and are of

Principal Dimensions and Weights of the Missouri Pacific Motorailer

Length overall, ft.-in.	75-0
Width over side sills, ft.-in.	9-6
Height, rail to top of carline, ft.-in.	12-6⅜
Height, rail to top of floor, ft.-in.	3-10
Light weight of body, lb.	80,900
Trucks, lb.	28,200
Total light weight, lb.	109,100
Water, fuel, oil, crew, etc., lb.	3,300
Total service weight, lb.	112,400
Revenue load, lb.	15,100
Total loaded weight, lb.	127,500
Seating capacity	34

the revolving type as the car is not turned at the ends of runs.

The side sash in the passenger compartment are double glazed and dehydrated, and the inner glass are shatterproof. The sash in the ends of the car have single shatterproof glass.

The passenger compartment is lighted by safety center ceiling fixtures which have blue night lights built in, and by individual lights in the safety basket racks over each seat. The floor is covered with carpet. There are venetian blinds at the windows. Drapes cover the piers between the windows. In the passageway between the baggage and passenger compartments is a G. E. water cooler.

The baggage-compartment floor is painted wood, with a small section of fish racks. The side lining is corrugated and the headlining flat. It is equipped with a desk and pigeon-hole case and is lighted by standard center and side-door fixtures.

The American Car and Foundry all-weather air-conditioning and heating equipment has a cooling capacity

Partial List of Equipment on the Missouri Pacific Motorailer

Truck frames	General Steel Castings Corp., Eddystone, Pa.
Journal bearings	The Timken Roller Bearing Co., Canton, O.
Clasp brakes	American Steel Foundries, Chicago
Snubbers	Houde Engineering Corp., Buffalo, N. Y.
Air brakes	Westinghouse Air Brake Co., Wilmerding, Pa.
Propeller shaft	Spicer Mfg. Corp., Toledo, Ohio
Engine	Waukesha Motor Co., Waukesha, Wis.
Torque converter	Twin Disc Clutch Co., Racine, Wis.
Exhaust snubber	Burgess Battery Co., Madison, Wis.
Battery	Electric Storage Battery Company, Philadelphia, Pa.
Radiators	Young Radiator Co., Racine, Wis.
Radiator shutters	Kysor Heater Co., Cadillac, Mich.
Sanders	Graham-White Sander Corp., Roanoke, Va.
Air conditioning	American Car and Foundry Company, New York
Multi-vent panels; headlight	Pyle-National Co., Chicago
Cooling fans	B. F. Sturtevant Co., Hyde Park, Boston, Mass.
Generators; generator regulators; air compressors; water coolers	General Electric Company, Schenectady, N. Y.
Sash	Adams & Westlake Co., Elkhart, Ind.
Venetian blinds	H. B. Dodge Company, Chicago
Seats	Coach & Car Equipment Co., Chicago
Light fixtures; basket racks	Safety Car Heating and Lighting Co., Inc., New York
Insulation	Gustin-Bacon Mfg. Co., Kansas City, Mo.
Horn	The Leslie Co., Lyndhurst, N. J.

Looking toward the rear of the baggage room—The locker on the right houses the air-conditioning equipment, including the motor-driven Freon compressor and the condenser unit—In the locker at the left are the electric regulator equipment for the two traction generators and other electric relays and controls

There are rotating seats with individual reclining backs for thirty-four persons

The underside of the Motorailer underframe

of 6½ tons. When heat is required the blower is turned over to push air across coils which are connected to the engine cooling-water system. Cooling air enters the car through Multi-Vent ceiling panels and is taken out through floor ducts in the side walls. During heating the air flow is reversed.

The operator's cabs at each end of the car are completely enclosed. The upper partition of the side, rear, and door of each cab is glass.

The Car Structure

The car frame is of welded construction with girder-type side frames. The side sills are carried down and under the vestibule step wells. Each side sill is made up of two rolled sections, one assembled in the underframe and the other in its side frame. The two members are riveted together in the final assembly of the body. The side plates are similarly divided between the roof and the side frame. The entire body structure is designed to withstand 100,000 lb. buffing load.

The end construction is all-welded. The main end posts extend through the floor and are secured to the end sill and to the draft sills. The latter extend through the bolster to an adjacent crosstie and are welded to the bolster.

The supports for the power plant extend from side sill to side sill and are arranged to give three-point suspension in rubber insulators to the combined engine and torque converter. Fabreeka insulates the supports from the side sills.

All framing members and sheathing are high-tensile steel.

Power Plant and Transmission

The engines, which are mounted under the floor, are six-cylinder horizontal type with 6¼-in. bore and 6½-in. stroke, spark ignition. Fuel oil is injected solid by a Bosch pump. Compression is low, permitting lightweight moving parts. Each engine is water-cooled by a fan and water-tube radiators. Air is drawn through the radiators from the car side and exhausted under the floor.

The transmission is a hydraulic torque converter with a direct-drive feature. Hydraulic or direct drive is selected automatically by the master controller which initiates electro-pneumatic shifting of a Twin-Disc clutch. Hydraulic drive is used for starting, accelerating, and extremely heavy grade work. When in direct drive, a free-wheeling unit built into the converter permits the engine to be cut to idling speed without dragging the car speed down.

Looking from the passenger compartment through the vestibule to the corridor between the toilets—The door in the background opens into the baggage room

Power from the converter drives one truck axle by means of a solid, universal-jointed propeller shaft. A pinion on the propeller shaft is constantly in mesh with two bevel gears in the axle housing. Forward or reverse

motion of the car is obtained by locking one of the bevel gears to the axle by means of a splined clutch.

Accessory, control, and lighting power is supplied by two G. E. 20-kw., 125-volt generators, one driven by V-belts from each engine. Each engine also drives a small 12-volt generator to supply power for engine starting, the headlight, and battery charging.

Each engine is protected against over-speed, reverse operation, high water temperature, and low oil pressure by an automatic fuel shut-off. Graham-White sanders are installed.

The operator's compartment is in the background at the right

Trucks and Brakes

The trucks are the General Steel Castings four-wheel drop-equalizer type with coil springs, Timken roller bearings and Houde snubbers to ease horizontal and vertical bolster motion and nosing of the truck. Insulating pads are installed at several points to deaden rail noise and shock. The A. S. F. clasp brakes are operated by truck-mounted cylinders, one on each side.

The brake system is the Westinghouse straight-air type SME, with deadman control and automatic sanding in emergency. The brake valve is self-lapping.

Railroads Use of Flame-Hardening Processes

(Continued from page 20)

rail and were hardened to between 400 and 450 Brinell. This hardness could have been greatly exceeded, but it was felt that 400 Brinell was most satisfactory for the application. Both wing rails and the point were hardened.

A large number of angle bars of various compositions and heat-treatments were hardened in July, 1939. The hardness of the untreated bars ranged from 207 to 235 Brinell. The hardness desired was specified at 400 Brinell, which was easily obtained. The middle 6 in. on the fishing surface was the only area hardened. These bars are still in service on a middle-western railroad and results of the test are being gathered by A. A. R. engineers for study.

The hardening of rail ends to postpone batter is now standard on several railroads.

Various types of gears for work equipment, cranes, and transfer tables, have proved excellent applications for flame-hardening. Two outstanding examples are of particular interest. The first is a driving gear for a pile driver. This gear was flame-cut to size from axle steel and flame-hardened. No machining was necessary on the teeth. The increase in service life has been 500 per cent. The second good example is the gear of a transfer table. This gear is 7⅛-in. pitch diameter, has 15 teeth, with a 4¾-in. face and formerly had to be changed every six months. The flame-hardened gear after 1¾ years of service shows no apparent wear.

Crane wheels make an excellent application for flame-hardening. These generally are made of chilled cast iron. In many instances, replacement of these wheels was found necessary because of broken flanges which could not be repaired. By changing to cast-steel wheels, reclamation by welding is permitted. Since there is no distortion from flame-hardening, such wheels can be machined to size beforehand and can be hardened to 650 Brinell in 12 min.

The hardening application on cast-steel turntable wheels is quite similar to that used on crane wheels. Turntable wheels have been flame-hardened to 500 Brinell in 8 min.

Pressing Dies

It has been the practice to use alloy cast iron for pressing dies used in the manufacture of such car parts as diaphragms and side stakes. The unhardened alloy cast iron can be replaced with the cheaper grey cast iron and flame-hardened. Dies so treated have from 300 to 600 per cent more service life. Furthermore, a flame-hardened die, when worn, can be reclaimed by oxy-acetylene welding, using a cast-iron welding rod and flame-hardening. Dies hardened by this method and then used for pressing material heated to 1,500 to 1,600 deg. F. have pressed over 400 pieces with no apparent wear.

Further Advance Expected

When flame-hardening was first introduced in the steel-treating industry several years ago it immediately demonstrated its advantages. Many manufacturers grasped flame-hardening as a means of lowering costs and increasing production. Many wild and fantastic predictions were made in their enthusiasm and today many of these predictions have come true. The process has advanced to a point where it is possible to evaluate it properly in the light of several years of successful laboratory and practical experience.

A few years ago it would have been impossible to machine a part complete to size and then harden, without distortion, only that portion where hardness was desired. For example, hardening only the teeth of an 8-ft. diameter gear, weighing 8,000 lb., would have been considered an impossibility. Today such jobs are common practice. The flame-hardening process still has many limitations, which are being rapidly overcome by research and experience.

Flame-hardening may never replace all other forms of heat-treating. It may not even equal some of them, but it gives to industry a new tool that will permit the hardening of many parts heretofore considered impracticable.

New York Central's

Manpower Conservation Plans*

By F. K. Mitchell†

Various plans discussed which will add to the available labor supply and its output—Employment of women in increasing numbers—Government agencies can help

Military conflicts, similar to the one in which we are now engaged, are won by that side having the most adequate personnel. Personnel, or manpower, is made adequate by reason of its sufficiency in numbers, training, clothing, material and transportation. This statement applies to the personnel of our armed forces and to the personnel of industry as well. The latter must be maintained even though there is a constant drain to the military services. Transportation, to be adequate, must be capable of handling peak movements of men, both during training and for actual combat, without interruption. It must be able to handle peak movements of raw materials to the factories and munition plants, and shipments of the finished products (clothing, food and material) to the point of consumption. This can only be accomplished by adequate personnel within the transportation industry, of which our rail systems are the heart, the arteries and the veins. These facts were impressed upon us during the first world war. They have since been recognized by military, political, industrial, labor and transportation leaders. That recognition is responsible, in a large measure, for the successes so far achieved.

What the New York Central Has Done

At the outset of this war, or specifically, as of January 1, 1941, the equipment department of the New York Central employed 26,117 men. Of this total, 16,922 were those coming under the classification of "skilled," including mechanics, helpers and apprentices. There were some furloughed employees in all crafts or classifications, but in most instances the number was so few that before many weeks had elapsed those available for recall to service were either non-existent or at least entirely inadequate to meet the demands of a rapidly growing business. When this situation developed, those responsible immediately set about devising and instituting measures designed to improve it.

The action taken was of three general classifications. First, that accomplished through federal and state government-management co-operation; second, that accomplished through management-labor co-operation; and finally, that accomplished primarily through the efforts of management.

In the first group came a closer co-operation with federal hiring agencies. All over the entire system the local representatives of the United States Employment Service and of the Railroad Retirement Board Employment Service were contacted and kept advised of our needs. The possibilities of assistance from them were exhausted before any other channels of employment were used.

In order to improve and make more effective those employees already in service, educational and training programs sponsored by national and state agencies have been instituted. As of November 1, 1942, 1,512 equipment department employees were enrolled in job-instruction courses and 1,411 employees in foremanship training courses sponsored by national and state agencies and universities.

In our endeavor to avoid losing to the draft much needed employees, and still comply with the provisions and intent of the Selective Service Act, we have co-operated both nationally and locally with the officials charged with the administration of that Act. We have asked for deferments only where the Act permitted and circumstances justified such requests. In the main, we have found local and national officials most sympathetic to our needs. On the other hand, certain features of the administration of the Act have affected us adversely.

To help further the national endeavor to solve the railroad manpower problem we have been furnishing a member for the Manpower Advisory Committee of the Office of Defense Transportation and likewise the Regional Mechanical Committee of that same office.

The second group of activities which involved management-labor cooperation has been quite varied. Early it was recognized by both parties that certain provisions in our labor contracts would have to be temporarily waived or amended in order to meet the emergency. One of these affected the possibility of expanding the ranks of our mechanics. Under the contract only mechanics with four years' experience could be hired as such, and only after completing a four-year apprenticeship could a man be made a mechanic. Negotiations between management and labor led to an agreement whereunder apprentices can be advanced to the rank of mechanic after completing two years of their apprenticeship, and helpers with at least two years' experience can be advanced to mechanics. This same understanding also provides how the seniority of men so advanced shall be established. Other understandings made possible an adjustment of certain limitations on hiring ages, some easing of physical requirements for hiring, and the removal from the labor contracts of certain inhibitions as to race and color. Management-labor conferences have likewise been held on questions of securing needed help, reducing absenteeism, wage and working conditions, the employment of females, more intensive participation of employees in safety activities and improved methods of handling controversial matters and avoiding them. These

* A paper delivered before the session of the American Society of Mechanical Engineers sponsored by the Railroad Division at the annual meeting held in New York, November 30-December 4, 1942.

† Assistant general superintendent of motive power and rolling stock, New York Central, New York.

activities have aided our conservation of manpower program very materially.

The third group of manpower conservation activities, conducted primarily on the part of management, have likewise been very effective. Realizing that every hour lost through accident or sickness meant some vital task either left undone or only superficially done, activities along these lines have been ceaseless. Hazards of all sorts are continually being sought and eliminated. Shop safety control boards consisting of workmen and functioning not only as safety committees, but also as judge and jury in safety rule violation cases, have been instituted. Additions have been made to nursing staffs and improved medical attention provided. Supervision and workmen alike have been encouraged to take advantage of Red Cross first-aid instructions, and hundreds have done so. The annual physical examination of supervisors has been made mandatory. Salt tablets have been made available to all during hot weather. Toilet and washroom facilities have been improved where material for such work could be obtained. Ventilation of welding and other shops have been improved by exhausters and fans where these were obtainable, and similar improvements are to be made if and when authorization for the material can be obtained. Certain engine terminals are having stalls lengthened, and shops are being improved in order that men may be better housed during cold weather. Other improvements of the same nature are to be made when authorization can be had for the needed materials.

Trend in Employment in the New York Central Mechanical Department

MECHANICS, HELPERS, AND APPRENTICES

	Total number on payrolls		
	Jan. 1, 1941	Jan. 1, 1942	Oct. 1, 1942
Mechanics	12,170	13,315	14,002
Helpers	4,085	4,584	4,874
Apprentices (regular & helper)	667	763	808
Total	16,922	18,662	19,684

Mechanics added	Jan. 1, 1941-Jan. 1, 1942	Jan. 1, 1942-Oct. 1, 1942
Mechanics hired new	1,581	912
Helpers advanced to mechanics	746	750
Apprentices promoted on completion of course	105	42
Apprentices promoted in advance of completion of course	146	126
Total	2,578	1,830
Mechanics lost		
Mortality	119	86
Retirement	213	99
To military service	54	246
Resignations to accept work elsewhere	522	510
Other causes	525	202
Total	1,433	1,143
Net increase:		
Number	1,145	687
Per cent	9.41	5.16

ALL OTHER EMPLOYEES

	Jan. 1, 1941	Jan. 1, 1942	Oct. 1, 1942
Total number on payrolls	9,195	10,416	11,018

Number added	Jan. 1, 1941-Jan. 1, 1942	Jan. 1, 1942-Oct. 1, 1942
Hired new	5,103	6,620
From other sources	677	523
Total	5,780	7,143
Number lost		
Mortality	88	93
Retirement	128	70
To military service	392	1,368
Resigned to accept work elsewhere	1,896	3,274
Other causes	1,460	1,401
Total	3,964	6,206
Net increase:		
Number	1,816	937
Per cent	13.02	5.95

Assign Work Where Help is Available

In a rail system the size of the New York Central the equipment shopping demand for various parts of the lines is a constantly varying factor. Peak demands in one location occur when ebb demands are occurring in another. The work load must, therefore, be distributed so that production will not lag at any point. Force increases of any consequence cannot be made, hence, the "move the work to the workman" policy has been adopted. Every month, equipment which would normally be shopped at one location is worked to another in order to level off a peak one place and build up the production at another. The necessity for this work equalization exists, not only between shop and shop, but between shop and engine terminal or car repair yard. Such a procedure requires careful planning and foresight, but we have found that if it is properly carried out, no one other factor is of such great value in conserving and making more productive our available manpower.

Personnel Training and Records

The training of personnel has been mentioned previously, in discussion of cooperation with national and state agencies to that end. Training not related to such agencies has been going on apace. Nearly two hundred supervisors are enrolled in a series of foremanship conferences sponsored by management. All tool-room foremen have attended course of study in tool tipping, grinding and design. Welding foremen have had made available to them training courses designed to teach them the latest practices so important to the conservation of materials and manpower. These supervisors are now actively engaged in disseminating the information they obtained through these courses to those who work with and for them. Apprentice training, both in the shop and the classroom, is being carried on. Each of our major shops has an apprentice instructor. Apprentice classroom instruction courses have been revised and modernized. Each apprentice has a sponsor in a supervisory position whose duty it is to aid the boy in every way possible. There are now on our rolls 808 apprentices as compared with 667 as of January 1, 1941.

The final phase of manpower conservation, which to a large extent is new, and now proving to be of great value, is the institution of a more adequate system of personnel records. In the past, personnel was something only the manager of personnel was interested in. Today, it is and should be the concern of every official. It was formerly a record of the past. Today it is a record of the present and a forecast of the future. We now know our mortality rate, our retirement rate, our rate of loss to the military services and to other industry, by localities, and for the entire equipment department. We also know our procurement rate and the number of vacancies by craft and class for the same jurisdictions. We further know exactly how many jobs, by I. C. C. classification and description, we have which can be handled by female employees. From a study of these rates and statistics we believe we have a fair picture of our future needs and some idea of what we can do about it.

There is every indication that an increased traffic demand, coupled with an ever increasing drain of manpower to the military service and to other industries, will make necessary the adoption of other measures.

This is emphasized by the fact that we now have over one thousand authorized positions unfilled.

Will Apprenticeship Dry Up?

In the apprentice situation, which is the key to skilled personnel training, we are caught between two conflicting demands. On one hand we desire to, and the Manpower Commission urges that we keep our apprentice ratio up to that permitted in our labor contracts (one apprentice to each five mechanics). This we have striven to do. But on the other hand, the Selective Service Act says we may ask for deferment only on such apprentices as have had two years' service. While the lower age limit of draftees was 21 years, the employment of apprentices at 18 years of age made it possible to augment our apprentice group by hiring young men of that age, and by the time they were eligible for induction into the armed services they were also eligible for deferment. Now that the age group 18 to 20 are eligible to draft, no such possibility exists. In some states even the hiring of men less than 18 years of age is illegal. Thus, unless some relief is obtained our apprentice procurement will become hopelessly inadequate. It is suggested by way of solving this problem, that an understanding be reached as to what actually is the minimum apprentice ratio required and then that deferment for apprentices be allocated to the railroads in numbers which will produce that ratio. Only by such a means can replacements through apprenticeship be made or the training of skilled employee replacements in adequate numbers be accomplished. Such a decision should be made by representatives of the A.A.R., O.D.T., U.S.E.S., administrators of the Selective Service Act and labor acting as a committee, whose decision would be final and binding. Deferments where the ratio was shown to be less than that figure set by this committee should, with possibly one exception, be mandatory on the part of the local draft boards and refusal of deferment where that ratio is known to already exist should likewise be mandatory. In all fairness, an exception to this rule should be considered. Every organization has within its ranks certain employees who are not properly qualified (and who may never be, either through lack of diligence or natural aptitude) to perform successfully the work for which they are being trained. There is no exception to this among the apprentices in the railroad industry. It would be an injustice to the railroad, to the nation, and such apprentices themselves, for their exemption to be requested. Consideration may well be given, therefore, by labor and management to the perfection of an understanding which will permit waiving of the deferment request where it is agreed that any apprentice has not the qualifications [illegible]r, nor the aptitude required successfully to be developed into an acceptable mechanic.

It should be recognized that special apprentices (graduate engineers) are also an absolute necessity on the part of any railroad. Heretofore practically no consideration has been given to the deferment of such men. For example, the New York Central has definite need for at least twenty-five such men in training constantly. A year ago there were twenty-one on our rolls. Today there remain seven, and of these, one has been classified 1-A and will be inducted shortly. It is suggested that consideration be given to allocation of deferments for special apprentices by the same group which establishes the apprentice ratio for regular and helper apprentices.

Mechanical Department Jobs Which Can Be Filled by Women

Classification	Number of classes of work	Total number of positions
Machinist (welder)	1	9
Machinist	30	52
Machinist helper	17	46
Boilermaker (welder)	1	10
Boilermaker helper	4	5
Blacksmith helper	2	7
Electrician	4	10
Electrician helper	1	1
Sheet metal worker (welder)	3	8
Sheet metal worker	4	16
Carman (welder and cutter)	2	25
Carman (painter)	3	30
Carman (upholsterer)	4	18
Carman (patternmaker)	1	1
Carman (others)	17	45
Carman helper	20	96
Crane operator	1	19
Oilers	1	3
Car cleaner	1	444
Truck operator	1	15
Janitor	1	11
Laborer (leader)	1	12
Laborer (common)	Various	559
Laborer (engine cleaner)	1	242
Laborer (sand men)	1	20
Laborer (supply men)	1	55
Laborer (water tester)	1	14
Laborer (grease-cup filler)	1	21
Laborer (turntable operator)	1	42
Laborer (material man)	1	13
Laborer (lubricator filler)	1	6
Laborer (engine watchman)	1	2
Total	131	1,857

Suggestions for Future Action

While the results of special agreements between management and labor permitting the promotion of helpers to mechanics and the promotion of apprentices to mechanics after two years' service have been good, the statistics show that the possibilities under those agreements have now been practically exhausted. In many shops and localities all available qualified helpers and two-year apprentices have now been promoted. Furthermore, such action has alarmingly depleted the ranks of the helpers. It now, therefore, seems necessary to go a step further, reopen negotiations and provide a satisfactory plan of further relief. Any such agreement will, to be effective, have to make provision for emergency or temporary seniority. It is a self-evident fact that any skilled or semi-skilled help as may be obtained through such agreements probably will not be needed by the railroad after the emergency is over. It is further apparent that the qualifications of such employees will not be such that they may be expected to be able to fill just any jobs to which normal seniority would entitle them. Consequently, it may be desirable to agree on the specific jobs which may be filled by such temporary or emergency employees for the duration of the war. If that is done some provision will likewise have to be made for the vacating of those jobs by the more skilled regular employees now holding them, and their arbitrary assignment to jobs which they can handle and the emergency employee cannot.

The Hiring of Women

Here, then, female employees enter the picture. There are many jobs on a railroad, other than those formerly recognized as coming within a woman's capabilities, which they can do which are now being done by men who could well do a heavier or more skill-exacting job. A recent check was made of the possibilities in this connection and a tabulation of the positions outside of office work which it is felt could be handled by female employees.

There are a total of at least 1,850 positions where such a possibility exists, and they include 131 different occupations. Through an arrangement of this kind a 6¼ per cent increase in force could be effected. No other known source of manpower, not essential for mili-

tary purposes, could approximate the relief which could be obtained by this means. Hence, it is obligatory that we take advantage of it.

Some features in connection with the employment of females, on work available as described above, will have to be considered. First, as to their seniority standing. Here the answer probably lies in setting them up as "temporary or emergency" employees and handling their seniority and job assignment in a manner already proposed for male employees coming under the same category. Next, some special training in supervision and work assignment of female employees will have to be given. This feature can readily be handled without outside assistance. Then the matter of adequate toilet and washroom facilities will have to be taken care of. A survey of our situation in this connection has already been made and it has been found that except for a very few cases no such facilities exist. In the procurement of the necessary materials for their construction, the assistance of the War Production Board will be needed.

Summary of Needed Actions

Summing up the actions considered necessary to insure the continuance of an adequate manpower procurement the following pertinent suggestions have been made:

1—Allocation of deferments for regular, helper and special apprentices to railroads on the basis of ratios set up by a joint committee of representatives from the A.A.R., O.D.T., U.S.E.S., labor and the Office of Selective Service Administration, under the limitations previously cited.

2—State legislation eliminating the inhibition against hiring men between the ages of 16 and 18, where such statutory inhibitions exist.

3—Job freezing in critical industries, including the railroad industry. In England today, no man or woman can obtain or quit a job in an essential industry without the written permission of the Ministry of Labor. Likewise, no firm can employ or discharge a worker without the consent of that government department. The result is that no one can strike, walk out or be locked out, and no one can lure the employee of another by an offer of higher wages. In Canada similar action has been taken, and in our country, to some extent, it has occurred in the lumber and mining industries.

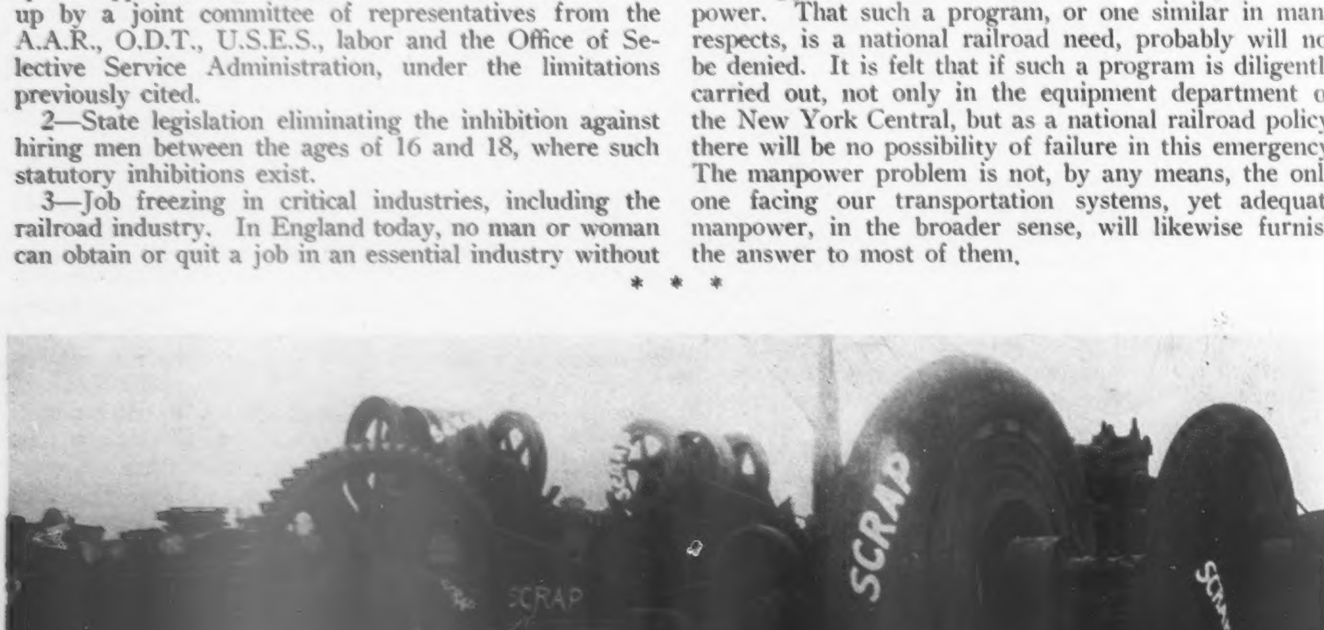
4—A management-labor agreement permitting the hiring of "temporary" or "emergency" employees, which likewise will settle the seniority question of such employees, and permit their assignment to jobs which they can handle and the re-assignment of present incumbents requiring greater skill to jobs which they can handle and the temporary or emergency employee cannot, it being understood that female employees shall fall in this category.

5—Prompt provision of trained supervision for female employees and likewise adequate facilities for their comfort and toilet needs.

6—A continued effort toward further efficiency in machinery, repair methods, labor saving devices, work load planning, safety, health, personnel training, personnel records and co-operation between management, labor and governmental agencies.

This six-point program, based on our past experience and our conception of future needs, is offered as our best suggestion for the maintenance of adequate manpower. That such a program, or one similar in many respects, is a national railroad need, probably will not be denied. It is felt that if such a program is diligently carried out, not only in the equipment department of the New York Central, but as a national railroad policy, there will be no possibility of failure in this emergency. The manpower problem is not, by any means, the only one facing our transportation systems, yet adequate manpower, in the broader sense, will likewise furnish the answer to most of them.

* * *



Part of 425 uprooted machines and pieces of equipment tagged for scrap in a yard of one of the Pullman-Standard Car Manufacturing Company plants. The dies used by Pullman-Standard in the construction of the first streamline train, The City of Salina of the Union Pacific, have also been scrapped, and equipment which has been stored against possible future needs or for sale and for which actual needs cannot be foreseen is being scrapped

Will Tomorrow's Traffic Require

Diesel or Steam Power?*

By L. K. Sillcox†

A discussion of the several factors involved in the selection of motive power; its operating characteristics and related costs

The Diesel-electric locomotive has effectively challenged the steam locomotive. True, during the early years of the present century, electrification was introduced and many authorities predicted that the electric locomotive would eventually displace steam power as traffic volume continued to mount. Events of the last few years clearly indicate this is not to be so except in relatively few instances. The use of electric locomotives anticipates the provision of power houses and power lines, feeder lines and trollies to meet maximum demands. The effect of this principle make it impossible to transfer such facilities, or even the locomotives themselves, to points where demands of fluid traffic may require. Electric traction is preferred by many in heavy traffic zones but the Diesel-electric displays identical operating characteristics to the electric locomotive except that its maximum capacity is limited to that of a portable power plant. The line of demarcation between the operating and economic conditions which could be better satisfied by the electric or steam locomotive is more plainly marked than between Diesel-electric and steam power. The case for steam power in sparsely populated territory of easy grades, for example, was very strong. On the other hand, electrification faced no opponents in terminal areas where steam power was excluded by municipal ordinance. This is not true of the Diesel-electric versus steam controversy except in cases where steam is prohibited by legislation. There are many borderline cases and personal preferences. The wide original cost advantage which the steam locomotive has enjoyed over its Diesel-electric counterpart is constantly being narrowed as the cost of steam power increases with refinements designed to increase operating efficiency, and Diesel costs are reduced through standardization and mass production methods. Neither excels to the point of total exclusion of the other. The result is that the evaluation of their merits for a given assignment is more difficult and entails a most exacting study before a logical selection may be made. The Diesel-electric locomotive is an effective compromise between electrification and steam power.

Capital Investment

Because of the more favorable availability characteristics of the Diesel, where it is utilized, a given traffic volume may be moved with a smaller motive power inventory, thereby requiring less capital investment if first costs were comparable. However, the original cost of a Diesel-electric unit is greater than that of its steam competitor, so no clear gain is indicated by the substitution of a reduced number of Diesels for steam power. Steady progress in design and production methods, partially effected by increased production volume, has gradually reduced the initial cost of Diesel locomotives to approximately $87.50 per hp. as contrasted with approximately $35.00 per hp. cost for steam power. Partially offsetting this decided cost advantage of the steam locomotive is the higher availability, and resulting more intensive utilization, possible with Diesel power. The average mileage figures for the competitive types in passenger service are as follows:

Type	Average Annual Mileage	Maximum Monthly Mileage
Diesel-electric	250,000	27,000
Steam	180,000	18,000

In other words, 18 Diesel-electric units will replace 25 steam locomotives of comparable capacity. If the assignment were such that either of the two locomotives whose horsepower characteristics are presented in Fig. 1 could be selected, the 18 Diesel-powered units would require a capital investment more than two and one-half million dollars greater than would the 25 steam-powered units. Lacking experience data, the life of a Diesel locomotive is a matter of conjecture, but it has been tentatively estimated to be 15 years, a value that may be revised upward as experience accumulates. Contrasted is the widely accepted service life of a steam locomotive of 28 years. Annual depreciation charges per installed horsepower are, then, $1.25 and $5.83 for the steam and Diesel types. For the above locomotives, annual depreciation would reach $23,333 for the Diesel while but

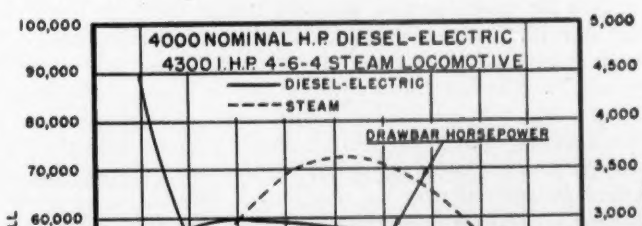


Fig. 1—Comparative drawbar horsepower and drawbar pull curves—Steam vs. Diesel-electric locomotives

* Abstract of a paper prepared for presentation before The Institution of Locomotive Engineers, London, England.
† First vice-president, New York Air Brake Company.

$5,375 would be charged against the steam unit. Competition has encouraged steam locomotive improvements which have forced upward the purchase price while the introduction of mass production methods and adherence to standardization have enabled the Diesel-electric manufacturers to lower their prices. Ten years ago the ratio favoring steam power was four to one, while today it is but two and one-half to one and there is no evidence to indicate that the trend will not continue. Actual initial cost data submitted by one railway is representative of the gains accruing to the Diesel in this account. In 1937, this railway purchased a series of steam locomotives with a 4-8-4 wheel arrangement for which the cost was 25 dollars per hp. Two years later, an order placed for a series, basically similar in design but differing somewhat in details, was billed at a charge of 30 dollars per hp. In 1941, locomotives of the 4-8-8-4 wheel arrangement cost 35 dollars per hp., indicating that the unit cost of steam power is steadily increasing. On the other hand, in 1937 a 5,400-hp. Diesel-electric unit cost the purchaser $104.00 per hp., while in 1941 a similar locomotive developing 6,000 hp. could be obtained at a 90 dollar unit cost.

Depreciation or Obsolescence?

Depreciation rates cannot be determined with strict confidence; for lack of experience data concerning the Diesel, and there is still controversy relative to steam locomotive life, even after over 100 years of accumulated experience. Reference to any railway equipment classification register doubtless will disclose steam locomotive ages of 15 years, 25 years, and even 50 years, although, in the latter case, probably no part of the original locomotive remains, aside from the number. Locomotive components are often replaced a part at a time to perpetuate the machine and this practice is the basis for the "no depreciation account" which has been advocated in some quarters. At first thought, one might be inclined to agree with this extreme view but it is not difficult to discern the fallacy involved, although possibly the term obsolescence should be substituted for depreciation. By proper maintenance, a steam locomotive can be maintained in such degree of mechanical efficiency as to be judged satisfactory when viewed in the light of efficiency standards obtaining at the time of its manufacture and the unit would not have been depreciated to the scrap pile. But advances may be accomplished in locomotive design or, just as important, operating demands may be increased to such extent as to render the locomotive economically unjustified and it is scrapped because of obsolescence.

Water Costs and Consumption

The Diesel-electric, burdened by a disproportionate initial cost, and consequent fixed charges, offers compensating advantages. An example is the lower water costs incurred in the utilization of Diesel power. Water costs as applicable to the steam locomotive are often ten per cent of the fuel charge, a very appreciable item of expense. If a Diesel locomotive is substituted in the same service, this charge will be reduced from ten to one per cent of steam locomotive fuel costs, if it be passenger service where steam generators are utilized for heating or air conditioning, and to a negligible value in freight service where no auxiliary power plant is required. It is difficult to overemphasize the importance of this reduction in water consumption, especially in operating districts where water of proper characteristics or in suitable quantities is not available. Railways operating steam locomotives in such territory resort to the use of auxiliary water cars, thereby increasing costs to a marked degree, in addition to curtailing revenue loading by an amount equivalent to the weight of water car and contents. Diesel power eliminates the necessity for chemically treating large volumes of boiler feed water. Inactive time required for boiler washing, testing, and repair, inherent in the steam locomotive, is not suffered when Diesel-electric power is employed and a higher availability results, a factor in reducing the number of units necessary for a given assignment.

Diesel Flexibility

The greater flexibility of the Diesel locomotive is another attractive characteristic which this power type displays. Since it is possible to operate such units singly, or in associated groups of two or more, centrally controlled, the amount of motive power assigned to a given train can be arbitrarily changed to meet traffic demands. Moreover, during the course of a run, the various units may idle during periods when full power is not needed. While operating on level, tangent track but a portion of the total power available is required to maintain operating speed and during this period one or more units may be idling, whereas on adverse grades, or when accelerating to speed after a slow-down or stop, the full complement of power available may be employed to overcome the greater resistances encountered. During low-demand periods, the various units may be alternately released for inspection and any light service repairs deemed necessary. Thus, maintenance may be accomplished en route with a consequent reduction in terminal delay; affording, at the same time, insurance against the development of defects which, if permitted to persist, may lead to damage of serious proportions entailing delay in terminals awaiting repairs at a high expense penalty.

When a complete failure of a steam locomotive occurs, the train is helpless until an additional locomotive is despatched to bring the train in. Rarely does a multiple unit Diesel locomotive fail completely. The delay is only that arising from the reduction in operating speed caused by insufficient power. The steam locomotive is at a distinct disadvantage because of its inability to present this same characteristic of flexibility.

Lateral Thrust Versus Dynamic Augment

Engineering officers, while realizing the importance of the lateral thrust developed with the swivel trucks used on Diesel motive power in conjunction with high concentrated loads on small wheels, nevertheless praise the Diesel-electric for its lack of overbalance, inherent in the conventional reciprocating steam locomotive. Differences of opinion obtain with regard to track effects in the case of locomotives having low centers of gravity such as the Diesel-electric or of the dynamic augment produced by the overbalance in the steam locomotive. The dynamic augment varies with the square of the speed and produces serious limitations to steam power in the high-speed zone. If a locomotive encounters a section of poor rail, in so far as adhesive condition is concerned when it is being operated near capacity, driving wheel slipping may occur, thus developing high rotative speed in consequence of which elevated track stresses result.

Efforts to improve this condition have included the reduction in weight of reciprocating parts by the substitution of lightweight, high-tensile, alloy steels. By increasing the number of cylinders to four, thereby providing two sets of reciprocating motion, as has been done in articulated designs, unit reciprocating weights have been reduced and the condition improved. The trend

toward ever larger locomotives has been reflected in massive reciprocating parts and has, therefore, increased the difficulties suffered from dynamic augment. The articulated design replaces the large engine by a multiplicity of smaller ones to do the same work. One locomotive has been constructed in which complete freedom from overbalance has been obtained by employing individual axle drive. If maintenance and other operative characteristics prove satisfactory, this design offers possibilities for high-speed operation.

Steam Locomotive Performance

A striking example of what can be accomplished when all components affecting operating results are intelligently administered and energetically policed is that of the Norfolk & Western. In 1925 the N. & W. handled 27 billion gross ton miles with 653 road locomotives while, in 1940, this same road handled 30 billion gross ton miles with 347 road locomotives. In 1925 gross ton miles per train hour were 32,212 but by 1940 this figure had increased to 57,984. The improved boiler efficiency is demonstrated by the reduction in unit fuel consumption. The coal consumed per thousand gross ton miles decreased from 147 lb. in 1925 to 89 in 1940. Improved dependability is evidenced by the reduction of freight locomotive failures from 388 to 74. At the same time, miles per freight locomotive failure more than tripled.

Table I—Comparison of Freight Locomotive Data—1925 and 1940—Norfolk and Western Railway

Account	Years 1925	Years 1940	Change, Per Cent + Increase – Decrease
Gross earnings	$105,218,991	$105,228,621	+0.009
Net earnings	26,565,292	31,383,976	+18
Gross ton-miles (thousands) (excl. loco. and tender)	27,037,267	30,178,450	+12
No. loco's. used	653	347	–47
Avg. tractive force—lb.	60,653	88,947	+47
Gross ton-miles per frt. train-mile (excl. loco. and tender)	2,613	3,805	+46
Avg. speed—train-miles per train-hour	12.3	15.4	+25
Gross ton-miles per train-hour (excl. loco. and tender)	32,212	57,984	+80
Lb. coal per 1,000 gross ton-miles (inc. loco. and tender)	147	89	–39
No. loco. failures	388	74	–81
Miles per failure	34,892	114,970	+230
Cost of loco. repairs per million tractive-force lb.-miles	$7.35	$4.99	–32

Many have maintained that the added refinements and auxiliaries built into modern steam power would measurably increase maintenance costs. This is not true in the case of the Norfolk & Western. On the basis of 1,000 gross ton miles, the maintenance costs in 1925 was 31.2 cents, while in 1940 it was 16 cents. The cumulative effect of these savings is reflected in the net earnings account where an 18 per cent increase is indicated with gross earnings for the two years remaining unchanged. The detailed statistics are shown in Table I.

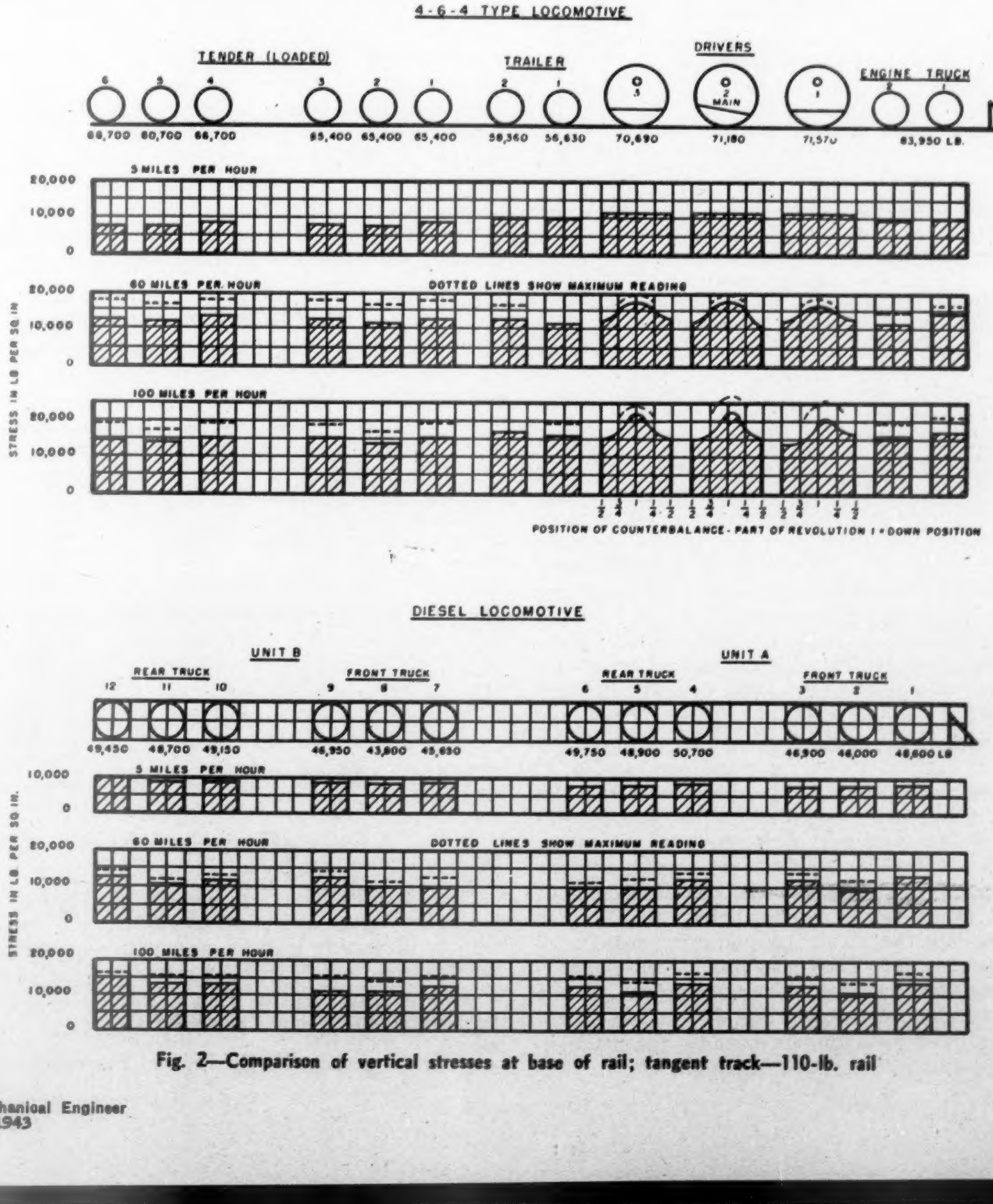


Fig. 2—Comparison of vertical stresses at base of rail; tangent track—110-lb. rail

Fig. 3 presents a comparison of the performance of a steam locomotive of 4-6-4 wheel arrangement and a 4,000-hp. Diesel-electric unit when operating over the same territory. These two locomotives are assigned to identical services and produce approximately the same amount of effort during the course of a run, the excep-

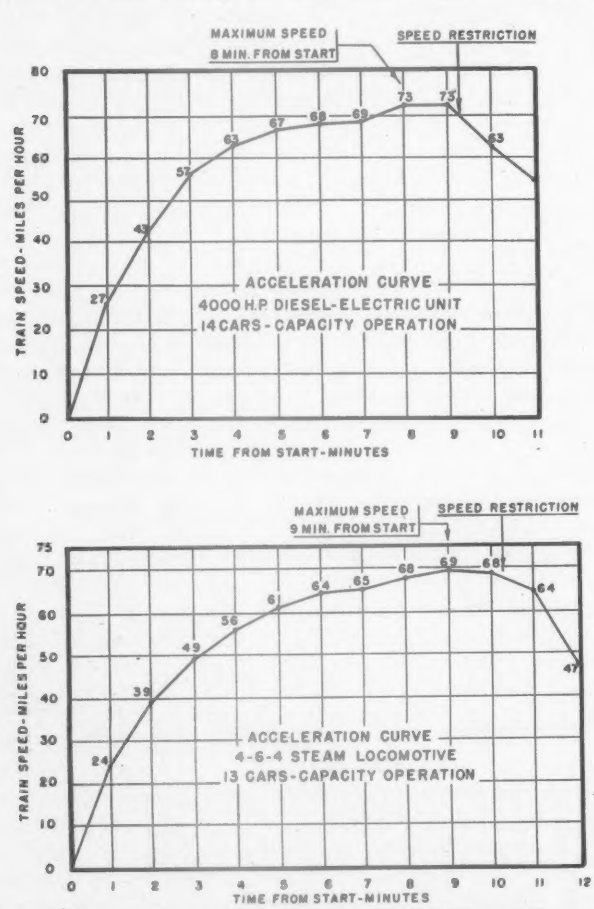


Fig. 3—Comparative acceleration curves—Capacity operation—Steam vs. Diesel-electric locomotives

tion being that, when necessary, the Diesel-electric can maintain on-time performance with a heavier train.

It might be argued by steam power proponents that this is not a true comparison and that other steam locomotives of the same wheel arrangement can surpass the capacity exhibited by the Diesel-electric unit. The reply in this case is that each of the locomotives is of the most modern design and the characteristics installed were selected as the best obtainable with the power type for the service to which they are assigned.

Comparative driver horsepower and tractive force curves are presented in Fig. 4 of a steam locomotive which develops, at a maximum, 5,000 cylinder hp. and of a Diesel-electric rated at 5,400 hp. These curves may be compared with those of the two motive power types as illustrated in Fig. 1. It will be noted that, in Fig. 1, the plotted values are taken at the drawbar, hence the effect of the difference in weight of the two units is reflected through the medium of locomotive resistance. These two sets of curves demonstrate clearly the superior power characteristics of the Diesel-electric throughout the low-speed range below approximately 30 m. p. h. and at once explain the greater accelerating capacity of this motive-power type. They also provide an explanation for the improved acceleration characteristics of the Diesel as graphically presented in Fig. 3.

Inasmuch as most switching operations are made in the low-speed range where the Diesel's excess tractive capacity may be utilized, the steam locomotive is at a decided competitive disadvantage. The Diesel is almost universally displacing steam power when new units are necessary or judged economical. Fig. 5 demonstrates the characteristics of six switching locomotives. For all switching speeds up to 6 m. p. h., the 1,200 hp. Diesel, Class A, delivers higher torque and thus can accelerate maximum tonnage more rapidly than can a steam locomotive of 2,100 hp. Its superiority over a steam locomotive of 1,500 hp. extends to 7 m. p. h., and in comparison with the 1,300 hp. steam locomotive, the Class A Diesel excels at all speeds up to 11 m. p. h. Since most switching operations are conducted at speeds below 6 m. p. h., the Diesel enjoys a definite advantage over its steam counterpart. Installation of the proper gear ratio between traction motor and power axle will enable a Diesel-electric switching locomotive to perform the assignments of a steam locomotive which has a horsepower rating of approximately two and one-half times that of the Diesel.

The favorable availability of the Diesel is attained, in part, by virtue of its characteristic which permits power to be cut off or on momentarily, thus eliminating any delay prior or subsequent to a servicing or maintenance operation. Fueling of the Diesel is required but two or three times per week and offers no serious problem. General overhaul, a yearly maintenance expense, requires from 10 days to two weeks, on the average, of non-productive time, permitting a maximum availability of approximately 95 per cent. On the other hand, a steam locomotive is ordinarily assigned to no more than 16 hours continuous duty a day, it then being relieved for servicing and maintenance. It must be withdrawn from service at 30-day intervals for boiler inspection and washing. Six thousand hours per year of the 8,760 possible, an availability of approximately 68 per cent, is deemed to be as much productive time as may be obtained from a steam powered unit.

Investment Comparsion

On the basis of the foregoing representative availability values, five Diesel switchers will replace seven steam locomotives. Diesels of 600 hp. have regularly performed the yard operations of a 1,400 hp. steam design. With Diesel power costing $87.50 per hp. and steam locomotives, $35.00 per hp., capital investment for the two alternatives would be:

Diesel: Five 600-hp. units at $87.50 $= 5 \times 600 \times 87.50 =$ $262,500.

Table II—Displacement Ratio of Steam and Diesel Locomotives

No. of Steam Locomotives	No. of Diesel Locomotives	Ratio—Steam to Diesel
7	5	1.40*
17	12	1.42
32	23	1.39
8	6	1.33
1	1	1.00

* Calculated—based upon availabilities of 68 and 95 per cent for steam and Diesel power, respectively.

Steam: Seven 1,400-hp. units at $35.00 per $= 7 \times 1{,}400 \times 35 =$ $343,000.

This condition does not hold for road power, however, due to the higher operating speeds and the Diesel investment is invariably greater than that required for steam. Neither does it hold in yard service if motive power inventory is insufficient to support the five to seven advantage displayed by the Diesel. Table II illustrates this point.

Approximately four years ago, a committee, composed of representatives of one railway and two Diesel-electric switching locomotive manufacturers, was organized for the purpose of determining impartially the relative operating costs of steam and Diesel power in yard service. After thorough and painstaking analysis of available cost data, this committee concluded that, including fuel, lubricants, water supply, enginehouse expenses, and crew wages, the cost per hour of operating a 600-hp. Diesel switcher was $2.68 while the similar cost, if a steam locomotive were selected for the same assignment, would be $3.90, or a difference in favor of the former of $1.22. A further credit of eight cents per hour was agreed upon for savings in locomotive crew overtime and hostlers' wages, with a resulting figure favorable to the Diesel of $1.30 per hour operated. The saving of eight cents per hour labor charge is dependent upon local conditions and is, therefore, subject to considerable variation. The preceding estimate is recorded as of interest in light of actual switching locomotive costs as submitted by three railways. Unfortunately, all railways do not adhere to a uniform accounting system, a fact which must be borne in mind when comparing such data. It will be noted by reference to Table III that Diesel switching locomotive hourly costs are less in all accounts with the

Table III—Hourly Switching Locomotive Costs

	Steam	Diesel	Diesel Saving
Railway A—600 hp. Diesels			
Fuel	$0.801	$0.224	$0.577
Water and other supplies	0.165	0.005	0.160
Lubricants	0.026	0.040	–0.014
Enginehouse expense	0.393	0.038	0.355
Repairs	0.950	0.277	0.673
Total	$2.335	$0.584	$1.751
Railway B—600 and 1,000 hp. Diesels			
Fuel	$1.12	$0.37	$0.75
Water, lubricants and other supplies	0.20	0.08	0.12
Enginehouse expense	0.47	0.04	0.43
Repairs	1.31	0.43	0.88
Total	$3.10	$0.92	$2.18
Railway C—1,000 hp. Diesels			
Fuel	$1.0636	$0.3267	$0.7369
Water, lubricants and other supplies	0.1111	0.0254	0.0857
Enginehouse expense	0.2279	0.0427	0.1852
Repairs	1.0633	0.5500	0.5133
Total	$2.4659	$0.9448	$1.5211
Railway B—600 and 1,000 hp. Diesels			
Fuel	$1.12	$0.37	$0.75
Water, lubrication and other supplies	0.20	0.08	0.12
Enginehouse expense	0.47	0.04	0.43
Repairs	1.31	0.43	0.88
Wages of enginemen	1.82	1.91	–0.09
Depreciation	0.23	0.55	–0.32
Total	$5.15	$3.38	$1.77
Railway C—1,000 hp. Diesels			
Fuel	$1.0636	$0.3267	$0.7369
Water, lubrication and other supplies	0.1111	0.0254	0.0857
Enginehouse expense	0.2279	0.0427	0.1852
Repairs	1.0633	0.5500	0.5133
Wages of enginemen	1.7813	1.7513	0.0300
Depreciation	0.1319	0.4157	–0.2838
Total	$4.3791	$3.1118	$1.2673

To this can be added a comparison of total costs per hour, less taxes, insurance, and interest, based upon the operations of Railways B and C.

exception of the relatively small lubrication expense where it is 50 per cent greater than the amount chargeable to the steam locomotive, and that the total saving per hour approximates $1.75.

A reduction in the cost advantage displayed by the Diesel is evidenced in each instance and a further reduction would be indicated if taxes, insurance, and interest were included. Even then, however, the Diesel would exhibit marked superiority and its retention in service would be economically justified. The steam freight locomotives in Table IV are of modern design, being built in 1938, and are comparable with the Diesel-electric power. The two classes of power are not, however, operated over the same territory and, because of local conditions, the steam locomotives do not handle as heavy trains as do the Diesel-electrics. The tonnage rating of the steam locomotives on a 1.27 per cent ruling grade is 3,200; of the 5,400-hp. Diesels with a 61/16 gear ratio the tonnage rating is 3,500 and, with a gear ratio of 62/15, the

Table IV—Freight Locomotive Operating Data

	Steam	Diesel	Diesel Saving
Mileage	455,216	216,725	......
Availability—per cent	75	90	......
Utilization—per cent	36	62	......
Car miles per train-mile	82.5	89.3	......
Gross ton-miles per tr.-mi.	3,400	3,801	......
Gross ton-miles per tr.-hr.	92,303	107,940	......
Train-miles per hour	27.15	28.39	......
Average number loco. in service	10	3	......
Average cost per loco.	$174,000	$490,000	......
Date built	1938	1941	......
Per Mile Costs			
Repairs	$0.30	$0.23	$0.07
Depreciation	0.08	0.20	–0.12
Fuel	0.33	0.28	0.05
Lubricants	0.01	0.05	–0.04
Water and other supplies	0.05	0.002	0.048
Enginehouse expense	0.04	0.01	0.03
Wages of enginemen	0.18	0.15	0.03
Total cost per loco.-mile	$0.99	$0.922	$0.068
Total cost per thousand gross-ton miles	$0.2908	$0.2254	$0.0654

Table V—Passenger Locomotive Operating Data (January to October, 1941, inclusive)

	Steam	Diesel	Diesel Saving
Mileage	2,212,872	1,813,522	......
Availability—per cent	75	90	......
Utilization—per cent	53	90	......
Average number of locomotives in service	17	7	......
Average cost per locomotive	$179,000	$365,000	......
Date built	1938	1936-1941	......
Per Mile Costs			
Repairs	$0.19	$0.16	$0.03
Depreciation	0.04	0.10	–0.06
Fuel	0.17	0.10	0.07
Lubricants	0.02	0.02	......
Water and other supplies	0.02	0.008	0.012
Enginehouse expense	0.02	0.012	0.008
Wages of enginemen	0.15	0.12	0.03
Total cost per locomotive-mile	$0.61	$0.52	$0.09

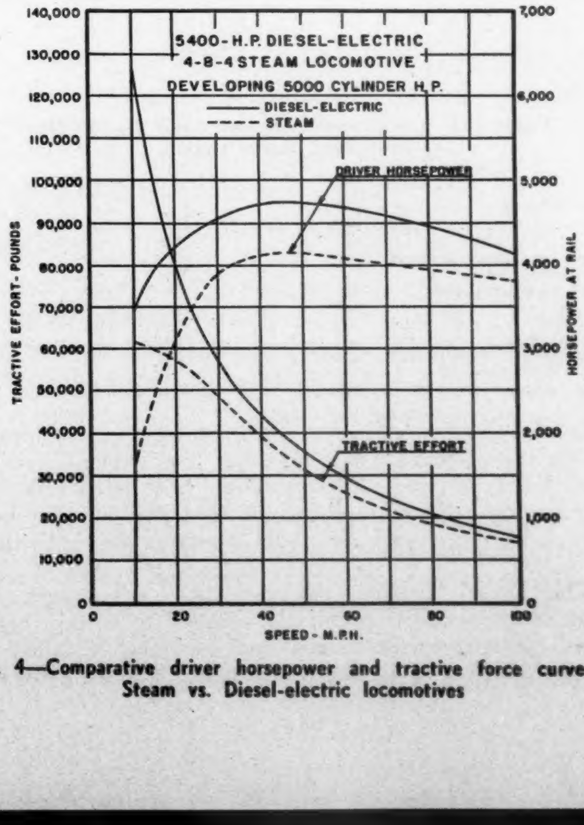


Fig. 4—Comparative driver horsepower and tractive force curves—Steam vs. Diesel-electric locomotives

rating is increased to 3,800. These tonnage ratings are based upon handling trains without helper service. As of possible interest, the effect of varying the gear ratio of these Diesels on tonnage rating with a ruling grade of 2.2 per cent when operating without helper service, and on maximum speed is injected here:

Gear Ratio	Tonnage rating	Maximum speed, m.p.h.,
59/18	1,700	80
61/16	2,000	70
62/15	2,300	65

The administration of the railway operating these locomotives judges a maximum speed of 65 m. p. h. to be ample for freight service and will, therefore, specify the 62/15 gear ratio on future orders so that the extra tonnage may be handled.

In analyzing the operating costs of the Diesel-electric passenger locomotive as compared with the steam locomotive, shown in Table V, allowance should be made for the fact that the Diesels are operated in high-speed service while the steam locomotives are handling heavy trains at lower rates of speed; consequently, if the steam locomotives were required to operate at the same speeds as the Diesels, even though they were handling light trains, the fuel and repair costs would increase. The passenger train and locomotive costs in Tables VI and VII were submitted by another railway as being applicable to sections of its system over which steam and Diesel-electric locomotives operate in comparable service.

Table VI—Total Costs of Operating Passenger Trains

	Steam	Diesel	Total Diesel Saving
Train-miles operated	325,378	237,626	......
Locomotive miles, including helper service and double heading	385,637	252,129	......
Locomotive miles per train-mile	1.185	1.062	......
Locomotive and train wages	$85,298	$65,254	$20,044
Fuel	65,775	40,162	25,613
Water, lubricants, and supplies	9,081	8,437	644
Train supplies and expenses	41,538	41,538	......
Helper and double heading	38,054	12,713	25,341
Car repairs	38,679	38,679	......
Locomotive repairs	90,462	49,901	40,561
Third man on Diesel	......	8,316	–8,316
Total train	$368,887	$265,000	$103,887
Total locomotive (inc. train wages)	$288,670	$184,783	$103,887

Caution must be exercised when comparing the total costs and savings resulting from Diesel operation, as computed by the two railways, inasmuch as one includes a depreciation charge while the other lists expense arising from helper service, doubleheading, and the practice of maintaining a third employee on the Diesel-electric unit. Comparison can only be made between the individual accounts.

Table VII—Locomotive Expenses per Train Mile (Including train wages)

	Steam	Diesel	Diesel Saving
Locomotive and train wages	$0.262	$0.275	–$0.013
Fuel	0.202	0.169	0.033
Water, lubricants, and supplies	0.028	0.0355	–0.0075
Helper and doubleheading	0.117	0.0535	0.0635
Locomotive repairs	0.279	0.210	0.069
Third man on Diesel	...	0.035	–0.035
Total	$0.888	$0.778	$0.110
Total train-cost per train-mile	$1.14	$1.12	$0.02
Total locomotive-cost per train-mile	0.89	0.78	0.11
Total locomotive-cost per locomotive-mile	0.75	0.735	0.015

The Diesel displays unquestionable advantages for yard assignments, is peculiarly adapted to certain high-speed passenger operations, and is being installed in freight service to a limited extent. The controversy as to steam or Diesel will be finally decided on strict economic principles. Ultimate selection depends, to a large extent, upon the ability of Diesel-electric manufacturers to offer their product at a price comparable with that of the steam locomotive. Should this be accomplished, the position of steam as the motive medium would be precarious.

The substitution of Diesel power would enable the elimination of costly boiler-water preparation facilities, water-service towers or track pans and of unsightly coaling plants. It would remove the necessity for enginehouse properties as we know them which could be replaced with modern, attractive maintenance plants.

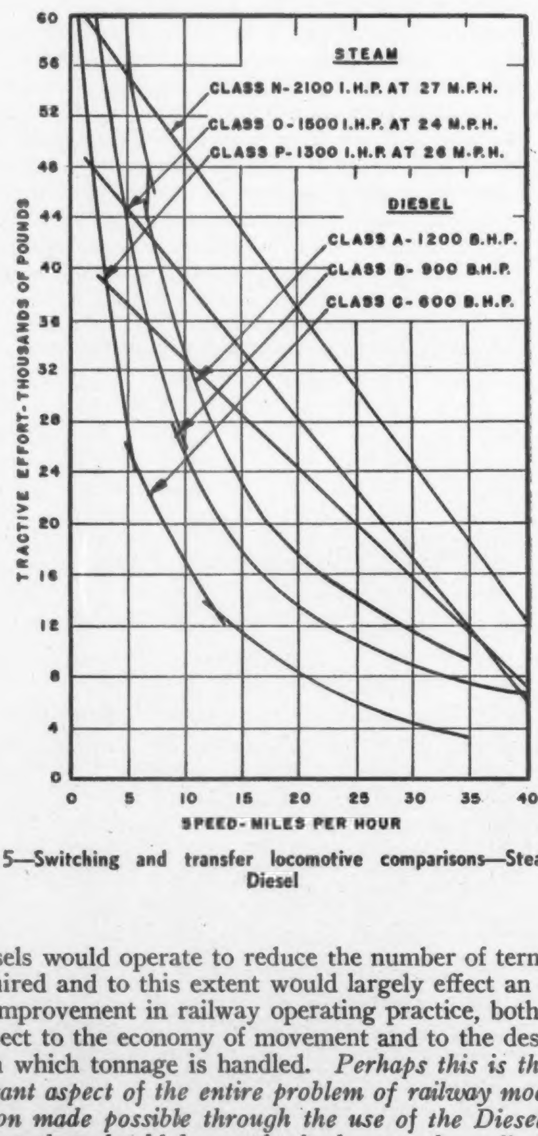


Fig. 5—Switching and transfer locomotive comparisons—Steam vs. Diesel

Diesels would operate to reduce the number of terminals required and to this extent would largely effect an overall improvement in railway operating practice, both with respect to the economy of movement and to the despatch with which tonnage is handled. *Perhaps this is the important aspect of the entire problem of railway modernization made possible through the use of the Diesel; the aspect that should be emphasized more than all others, thus eliminating excuses to stop trains in transit unnecessarily.** Further, if the practice of handling traffic in train-load lots is forced upon the railways by competitive rate situations effected through other forms of transport attempting to obtain the traffic, it merely signifies that railway raffic will represent unit movements covering great distances between originating and final terminals with no intermediate attention affecting train consist required. Railways have but one future; namely, to handle traffic at wholesale rates and to discontinue conditioning rates upon a retail basis.

* The italics are ours.—Editor.

EDITORIALS

Our New Electrical Department

This issue of *Railway Mechanical Engineer* presents you with a newly created electrical department. The innovation is in fact a consolidation of this paper with our former sister publication, Railway Electrical Engineer, which has served electrical men in the railroad field for the past thirty-three years. Our electrical editorial staff has been kept intact and it will now serve the interests of that large majority of electrical men who are in the mechanical department, and the mechanical men who are interested in electrical subjects will no longer need to subscribe to two publications. Similarly, the electrical men who formerly subscribed to Railway Electrical Engineer will find in the *Railway Mechanical Engineer* the kind of articles they have been accustomed to reading and also other information which will keep them in touch with the broader aspects of work being done by the mechanical department.

Under the title "Electrical Leads" (page 50 of this issue) is material intended particularly for the electrical man. This includes the "Consulting Department," with questions and answers on pertinnent current subjects. Among the "New Devices" will be found several which are essentially electrical. In the news pages there are items which specifically concern the electrical readers.

The contents and layout of future numbers may vary from issue to issue, but there will always be a fund of material for the electrical man. Also those articles in the body of the paper which concern such subjects as locomotives (electric, Diesel-electric and steam), shop facilities, air-conditioned and electrically lighted cars, will appear with more complete information on electrical equipment than was formerly supplied in the pages of *Railway Mechanical Engineer.* We look forward to serving our readers and the railroads even more effectively than we have in the past.

"The Last Straw"

The old saying about the last straw being the one which breaks a camel's back has a parallel in the railway transportation field in the demonstrated fact that the last car on an overloaded Diesel-locomotive-driven railway train is the one which causes the trouble. Not only is the excess weight involved important, but the time element must be considered, as the overload capacity of both the Diesel engine and the electric transmission machinery is absolutely dependent upon how long the load must be carried.

Rather definitely limited load capacity is a recognized characteristic of any internal combustion engine-driven equipment, including Diesel locomotives, and railroads must fully recognize this limitation in order to get the best results from the remarkably efficient and effective new tool which has been developed and is offered to them in the form of Diesel motive power. Energetic and often somewhat hard-fisted railway superintendents and other operating officers will do well to remember that because a Diesel locomotive handles a full load on a tough run one day, the addition of another car the following day is not always the best way to increase ton-mileage and get trains over the road.

This point may be emphasized by another homely illustration of what happened in the case of a farm-machinery dealer who sold a small gas-engine-driven tractor to a farmer with the guarantee that it would pull either a one- or two-disc plow in any kind of ground, day in and day out, with no mechanical trouble. After a short test, the farmer returned much pleased to report that the tractor was even better than specified and could, in fact, pull a three-disc plow. The dealer advised strongly against this practice and, when pressed for a reason, said to the farmer, "Do you see that building over there about 200 yards away? How many times could you walk there and back in a day?" The farmer said he didn't know, but could probably keep going about all day. The dealer asked, "How many times could you go at a dog trot?" The answer was again indefinite, but indicated that certainly far fewer round trips could be made than at a walk. Again the dealer asked, "How many times could you go running at top speed?" The farmer replied "H——, I probably couldn't get there once!" The dealer said, "Alright, don't put the third disc on that plow, or if you do, bring your check book the next time you call, for my company refuses to be responsible for what happens to the tractor."

The sequel of this reportedly true story is that the farmer didn't believe the dealer. He put the third disc on the plow; hauled it successfully for only a week; and reappeared at the dealer's office with a sheepish expression on his face and—a check book in his hand. The moral of the story is not hard to find. Unless railroads are willing to pay the price in unnecessary replacement and repair expense, train delays and motive power out of service, they will not overload their Diesel locomotives. It is far better, especially for railroads having little experience with Diesel motive power, to adopt the conservative ratings specified by manufacturers who know what the equipment will do and have a definite incentive to see that it gives satisfactory service over a more or less extensive period of time.

In connection with the subject of rating Diesel locomotives, it is interesting to note that a sub-committee of the American Society of Mechanical Engineers, Railroad Division, has developed the preliminary draft of a test code to establish the continuous and intermittent ratings of Diesel motive power and this code, after being checked

by the Association of American Railroads, Mechanical Division, and the A. S. M. E. Power Code Committee, will doubtless offer railroads a more scientific and practicable method of determining just how heavily Diesel locomotives should be loaded for best results on a long-time basis. The preparation of such a test code to determine Diesel locomotive ratings will fill a long felt want and help railroads meet the motive power situation which confronts them in 1943.

Can Locomotive Repair Costs Be Compared?

Railroad mechanical men have, for years, sought a basis upon which to compare the cost of repairing locomotives. The effort to determine such a basis of comparison has been inspired by a variety of reasons. Some students of this question have felt that if an equitable basis of cost comparison could be arrived at it would be a valuable help in relating the maintenance experience to the problem of design with the result that design would improve to such an extent that maintenance cost would automatically be lowered. Others have approached the question with the idea that locomotive repair cost is a reflection of the efficiency of the organization and facilities with which the repair job is done. Such being the case repair cost data could be used as a measuring stick to compare the performance of one shop with another—either on the same road or on different roads.

Those who have made a study of motive-power repair costs have usually arrived rather early in the study at a point where, in their own minds, there is serious doubt as to the value of the commonly used locomotive-mile basis of expressing cost. Such doubt having arisen, it is natural to give consideration to what is hoped will serve as a more accurate indicator.

If consideration is given to the fact that the job of repairing a locomotive is not necessarily one of restoring that locomotive to a mechanical condition such as existed at some previous shopping period, but rather is one of conditioning it to render a given number of miles of road service, the question of repair cost may appear in a somewhat different light. A locomotive, on most roads at least, is not a machine that is rebuilt in kind as it passes through the shop for repairs but is an assembly of many parts, or groups of parts that by themselves may or may not be rebuilt in kind at that particular shopping, depending on whether or not, in the opinion of a supervisor or inspector, the parts will continue to function satisfactorily until the next assigned period of mileage has been run out.

If the person studying this question were to break down a locomotive into important groups of assemblies and parts and then secure the necessary data to determine the mileage life of these groups together with the cost of their repairs, it would soon be discovered that two locomotives of identical wheel arrangement and tractive force, though of different design as to major parts and special equipment, would show a difference in repair cost even though operated side by side in the same service and accumulating the same number of miles per month. Conversely, two locomotives identical as to wheel arrangement, tractive force and general design and equipment, but operated the same number of miles per month over divisions of the same railroad having different physical or operating characteristics, would show a difference in repair cost.

Like so many other problems involved in railroad operation, this one of locomotive repair costs lends itself to the possibility of many solutions each varying somewhat in direct relation to the fluctuations in the many factors that have a bearing on the ultimate result. It is possible to have equality in the dollar value of total repair expense and have a wide fluctuation in locomotive mileage between two periods of time. The result will be a difference in the repair cost per mile. One road, likewise, may burn its locomotive fuel just as efficiently as another road but have traffic of a character that produces a high gross ton-mile figure. Of two such roads one will show a fuel performance in pounds per thousand gross ton-miles that will be distinctly more favorable than the other road.

In all of this search for detailed and accurate cost data relating to railroad operation it is always worth while to keep in sight the ultimate objective. It may be true that the cost of locomotive repairs per locomotive-mile is not an accurate indicator of the relative efficiency of the men and facilities used for repair work, but it may be a reasonably accurate basis of comparing the cost of restoring serviceable locomotive miles. The average per-mile cost, compared with some previous operating period gives the mechanical man a fair idea as to how well he is holding up his end of the job.

Nine and a Half Million Men Under Arms

Present military plans of the United States contemplate armed forces (all branches) of 9.5 million men at the end of 1943. This will draw heavily on the nation's total labor force as the year progresses.

A study of manpower requirements to fulfill this plan and of the sources from which the labor force is to be recruited was made by The Brookings Institution during 1942. This study assumed an increase in the armed forces during 1943 of 3.8 million men to bring the total up to 7.9 million during the year and indicated a possible increase of 3.5 million in the total labor force, including men under arms. With no change in the number of agricultural workers (9.6 million) an increase in non-agricultural workers of 1.2 million to a total of 43.5 million is estimated. This is made possible by the employment of 1.5 million of the 2.7 million workers unemployed during 1942, the addition of 700 thousand from the year's increase in working population, a possible few thousand immigrants from Mexico, the employment of another 800 thousand to be obtained from young people in school and from those now

retired, and about two million homemakers. Projecting the study into 1944, on the assumption that armed forces will reach 9.5 millions by the end of that year, the total labor force is set at 65.1 million, a further increase of 2.9 million over 1943. For this increase reliance is placed on the population increase, a further increase of school children and aged workers equal to that of the preceding year, and another draft on home-workers of 1.3 million; the net effect on non-agricultural workers is an increase to 45 million. The increase in women employed is 3.3 million in two years, which is at least 60 per cent of the non-farm women over 45 years of age who have no young dependent children.

By a progressive reduction in the production of private goods and services from 92 billion dollars in 1942 to 70 billion dollars in 1943 and 60 billion dollars in 1944, and a moderate reduction in government non-war purchases, the study estimates that, with such a labor force, purchases on war accounts might be stepped up from 35 billion dollars last year to 66 billions this year and to 84 billion dollars in 1944. To accomplish this it is estimated that the actual weekly hours worked will have to be increased from the average of 42.5 in 1942 to 48 in 1944, which will involve schedules averaging at least 50 hours a week and would require schedules well beyond 50 hours in some cases.

Figures recently announced by Paul V. McNutt, chairman, War Manpower Commission, indicate requirements somewhat higher than those assumed in The Brookings Institution study. Mr. McNutt's figure for the total labor force for the end of 1943, including armed forces, corresponds closely with the Brookings' figure for 1944.

An article by F. K. Mitchell, assistant general superintendent motive power and rolling stock, New York Central, which appears elsewhere in this issue, presents a thorough-going study of the manpower situation which mechanical departments of the railways are facing and proposes measures to meet the situation. Studies on his own road disclose possibilities for the employment of women to the extent of 6¼ per cent of the total number of employees in the mechanical department. This compares with the increase in women workers estimated by The Brookings Institution of about 7.6 per cent of total of non-agricultural workers.

It is evident that the task facing the United States is one which cannot possibly be accomplished without upsetting customary methods and arrangements throughout industry. With present provisions for the control of manpower, it should be possible for the railroads to secure such deferrments as are necessary to prevent dangerous disruptions of service. To rely on this possibility to the exclusion of all moves to take care of themselves, however, will be inviting disaster for which no one but themselves can be blamed. There seems no way out but the employment of women for some of the jobs which have customarily been considered man's work. Preparations for this change cannot be started too soon.

New Books

THE STEAM LOCOMOTIVE. *By R. P. Johnson, M. E., chief engineer, The Baldwin Locomotive Works. Published by the Simmons-Boardman Publishing Corporation, 30 Church street, New York. 502 pages, illustrated. Cloth bound. Price, $3.50.*

This book contains a wide range of information, including bases for locomotive proportioning, data concerning operation and testing, and an extensive study of motive-power economics. It should be a useful reference for engineers, railway officers whose responsibility includes general supervision of motive-power selection and performance, supervisors interested in locomotive operation, and students of motive-power performance, both young and old. The author makes no claim to the originality of any of the material in the book; much of it was scattered through periodical literature and treatises dealing with restricted aspects of the steam locomotive or its use until he brought it together. There are 26 chapters. Roughly, these may be divided into three groups—those which deal with the locomotive and its performance; those which discuss conditions outside the locomotive affecting its performance, and those on various aspects of motive-power economics. In the second group are chapters on Locomotive Fuels, Water for Boiler Use, and Curves. The chapter on water is a concise treatise on the selection and treatment of boiler feedwater and includes a discussion of caustic-embrittlement phenomena. Particularly worthy of mention are the chapters on High-Speed Trains, Streamlined and Lightweight Trains, and Motive Power for High-Speed Service. The second of these deals effectively with the relative economic value of weight reduction and streamlining under various conditions. In a chapter on Resistance, locomotive streamlining is also discussed. The motive-power chapter, among other phases of the subject, compares the characteristics of steam and Diesel locomotives, including operating costs, as does also the chapter on Motive Power for Switching Service. Three chapters at the end of the book are devoted to motive-power economics. These are The Relation of Locomotive Operating Expense to Net Operating Income; Locomotive Repair Costs, and Economic Life. To leave the book without some reference to the bulk of material which is devoted to the steam locomotive and its operation would throw the scope of its coverage considerably out of focus. The book does not deal with boiler design nor with the design of other details. There are, however, extensive chapters on combustion and evaporation. Chapters in which is included current data not customarily available in handbooks are those on Tractive Force, Horsepower, and Counterbalancing. Generally speaking, in the field of locomotive proportions and performance, it contains much data and information which is directly related to modern practice. The treatment throughout is essentially practical.

Welding Liners on

Worn Driving-Wheel Centers*

By C. H. Easun†

Canadian National realizes savings in use of one-piece welded liners—Method also proves satisfactory from operating standpoint

The increasing number of driving-tire failures which were occurring on fast passenger and freight locomotives caused concern to the officers of the Canadian National mechanical department. During the investigation of these failures it was discovered that tires on newly built power, or on engines which had wheel centers turned before new tires were applied, had not failed. This indicated that the cause of the tire breaking had

Two-pass welding gives this finish when applying one-piece liners to driving-wheel centers

some relation to the condition of the wheel center. Although the standard shop practices were followed in turning the rims when out-of-round, a number of rims were apparently pitted or distorted and the new tires applied did not have a perfect metal-to-metal contact.

The decision was made that all wheel centers would be turned when tires were being applied so that at each application of a tire there would be new metal contact between the two surfaces. It then became necessary to place a limit on the permissible reduction in the diameter of the wheel center. This limit was set at ¼ in. less than standard diameter. When wheel centers had been reduced to this limit consideration was given to some method of restoring them to the original diameter. The A.A.R. recommendation was adopted.

This recommended method consists of the application of a steel plate liner in three sections which were welded to the wheel center. While this method was partially successful trouble was experienced in applying the sectional liner. It was found almost impossible to obtain a metal-to-metal contact between the surfaces which is essential before any welding is attempted. Further experimentation developed the idea of applying the liner in one piece and this plan was finally adopted.

Detail of the weld on the outer side of a driving wheel center which is restored to size by the application of a one-piece liner

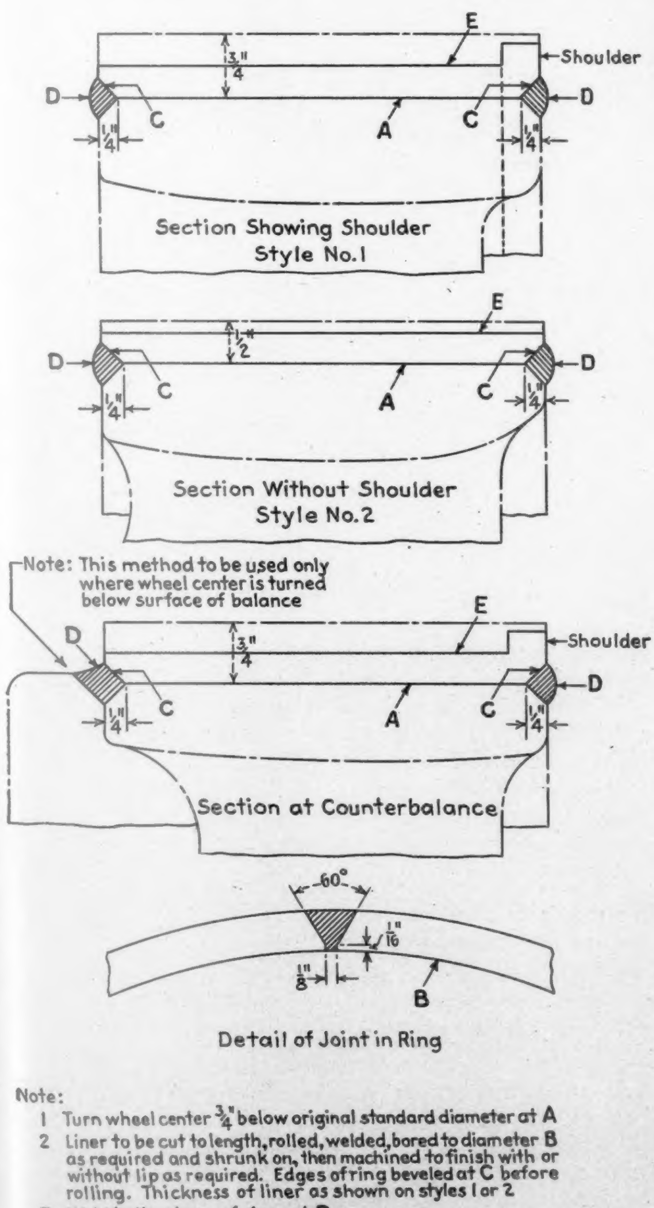
* A prize-winning paper submitted in the recent $200,000 Industrial Progress Award Program of the James F. Lincoln Arc Welding Foundation.

† Assistant mechanical engineer, shop methods, Central Region, Canadian National, Toronto, Ont., Canada.

A mild-steel liner is cut to length and the edges are bevelled on a plate planer. The liner is rolled to the required diameter after which the joint is welded. This ring is then placed in a large boring mill and bored to an inside diameter which will provide a shrink fit on the wheel center. The wheel center is turned to a diameter of ¾ in. less than the standard diameter, and the edges are bevelled. The ring is then heated, using a gas-fired heating ring placed on the wheel center, and allowed to cool. When cool, the edges of the liner are arc welded to the wheel center.

Cost of Machining Old Wheel Centers Mounted on Axle for Application of Steel Bands to Restore Original Diameter

Labor (including cost-of-living bonus)		
Machining wheel centers ready for band, 5 hr. at 75 cents	$3.75	
Turning bands after application, 5 hr. at 86 cents	4.30	
Shop expense	4.03	$12.08
Manufacturing bands—material		
Mild steel, 480 lb. at 3¾ cents per lb.	18.00	
S. A. E. electrodes for welding, 65 lb. at 10 cents per lb.	6.50	
Stores expense	1.47	25.97
Labor (including cost-of-living bonus)		
Machining bands before welding and rolling, 10 hr. at 86 cents	8.60	
Welding joints in bands, 1 hr. at 86 cents	.86	
Bore to fit wheel center, 12 hr. at 86 cents	10.32	
Weld to wheel center, 18 hr. at 86 cents	15.48	
Shop expense	17.63	52.89
Total		$90.94



Various conditions which may be met in different types of wheel centers

Driving wheel centers which have been restored to size by the application of one-piece welded liners—Proper machining and shrink-fitting of the liner assure good metal-to-metal contact before welding

Cost of Making Up and Applying Two New Wheel Centers and Two New Crank Pins to the Old Axle

Material		
Two wheel centers, 4,600 lb. each	$1,080.00	
Two crank pins, 465 lb. each	120.00	
Stores expense	72.00	
		$1,272.00
Labor (including cost-of-living bonus)		
Remove axle and crank pins, 3 hr. at 75 cents	$2.25	
Machine two new wheels, 40 hr. at 86 cents	34.40	
Apply wheels to axle, 3 hr. at 75 cents	2.25	
Machine and apply hub liners and keys, 7 hr. at 86 cents	6.02	
Turn crank pins and bore crank-pin holes, 7 hr. at 86 cents	6.02	
Apply crank pins, 2 hr. at 86 cents	1.72	
Turn wheel centers for tire, 3 hr. at 86 cents	2.58	
Shop expense	27.62	
		82.86
Total		1,354.86
Credit for scrap		75.99
TOTAL		$1,278.87

The ring is tack welded at intervals on both sides of the wheel, using a $\frac{5}{32}$-in. shielded-arc electrode. The pair of wheels, mounted on the axle, are placed on end as this position facilitates down-hand welding. Two operators, each using a Lincoln 400-amp. dual-control welding machine do the work. One operator welds on the lower wheel and the other on the upper wheel. The first pass is made with $\frac{5}{32}$-in. shielded-arc electrodes, the second pass with ¼-in. shielded-arc electrodes. These electrodes are of the same type as Lincoln Fleet Weld No. 7. Upon the completion of one side of each wheel, the position of the wheels is reversed and the operation repeated.

This method is less costly than the application of the three-piece liner, chiefly because extensive clamping op-

Comparative Statement Showing Estimated Savings

Cost of applying two new wheel centers with new crank pins to the old axle	$1,278.87
Cost to restore wheel centers to the original diameter by the application of steel bands, arc welded to the wheel center..	90.94
Saving per pair of wheels	$1,187.93
Saving per wheel	593.96
Proportionate cost saving, per cent	92.2
Estimated number of wheel centers which will be reclaimed per annum over the entire system represent a total saving of	$29,698.00

erations are unnecessary and the application is easier. It is believed that longer life is obtained from wheel centers which are reclaimed in this manner. The steel liner is tougher than the original casting and provides a better seat for the tire. Necessary figures to substantiate this statement, however, would be difficult to obtain as it is almost impossible to keep an accurate record of the service of any particular wheel. It is realized that, with present-day high speeds and maximum loadings, the closest attention should be given to the condition of wheels and tires.

The tables give the cost of various operations. From them it will be observed that the method described shows a considerable saving in labor and material.

Questions and Answers On Welding Practices

(The material in this department is for the assistance of those who are interested in, or wish help on problems relating to welding practices as applied to locomotive and car maintenance. The department is open to any person who cares to submit problems for solution. All communications should bear the name and address of the writer, whose identity will not be disclosed when request is made to that effect.)

Welding on Worn Brake Shafts

Q.—Can worn freight-car brake shafts be welded successfully?

A.—Worn freight-car brake shafts can be built up by welding. The areas worn by contact with the ratchet wheel and brake wheel can be rebuilt to near the correct size using the torch and a mild-steel rod. After welding they can be hammered to the exact dimensions. Anneal brake shafts after welding. Cracked or broken brake shafts should not be welded.

Flashing a Generator

Q.—Would you explain what is meant by flashing a generator?

A.—Occasionally, after a generator has been idle for some time or has been overhauled, it will refuse to build up its voltage when started. One method of curing this condition is to "flash the generator." Flashing is a method of establishing the residual magnetism of the field structure with the correct polarity to cause the machine to generate. It is done by passing a relatively heavy current through the field windings momentarily using another machine or other external source of direct current.

Welding Broken Guide-Yoke Castings

Q.—Can a guide-yoke casting which has been broken in two where it fastens to the guide-yoke brace be welded successfully without having too much distortion?

A.—There is no reason why the guide-yoke casting cannot be welded satisfactorily without any distortion. Vee out the break on both pieces from each side leaving a $1/16$-in. line in the center of each that is uncut. Drill a heavy plate, 1 in. or more in thickness to match the link-trunnion fit on the guide yoke. Fit the pieces together and bolt the heavy plate in place. This will hold the broken piece square with the balance of the yoke. Insert three short pieces of $3/32$-in. bare rod between the edges of the vee to care for contraction in the weld. Two operators, welding from both sides at the same time should make a $1\frac{1}{2}$-in. tack weld at the bottom of the vee. The next tack weld is made at the top of the vee and the third and last tack is made in the center. Welding is then carried from the center tack to the top one. Still welding from both sides, the operators drop down to the bottom tack and complete the weld. When it is possible, a 10 per cent reinforcement is added to the weld. A guide yoke welded in this manner shows no distortion and when cool may be applied without machine work.

Repairing Throttle Seats

Q.—Is it possible to fill in a worn or steam-cut spot in a locomotive throttle seat without preheating?

A.—Worn or cut places in the throttle valve seat in the "bootleg," or stand pipe, can be filled with wear-resisting bronze by local preheating. Using a large welding head in the blowpipe, the flame is played around the bowl of the "bootleg" until the casing is brought to the "sizzling" point. A small welding head is then substituted for the large one, and, using a small diameter rod, the bronze is applied as quickly as possible. The resulting weld is then chipped and filed to facilitate subsequent grinding.

Welding Repairs On Reverse Shaft Bearing

Q.—What method do you recommend for building up reverse-shaft bearings?

A.—Many conditions enter into the rebuilding of reverse shaft bearings. When cast-iron or steel boxes are used on the reverse shaft, it is advisable to use bronze on the bearings. Care must be exercised when rebuilding with bronze to be sure that the shaft is clean. The operator should deposit enough bronze so that the bearing will machine free from holes and also that the box may be bored if necessary.

When the boxes on the shaft are bronze or have bronze caps, as sometimes happens, a more successful repair will be made if the shaft is rebuilt with steel. Usually a heavy deposit is needed and a large electrode should be used, preferably $1/4$ in. either bare or coated. A deposit of coated rod will machine more easily and give a better surface.

Welded Handles in Locomotive Coal Picks

Q.—We have been experimenting lately with pipe handles in our locomotive coal picks. The blacksmith has been putting these on and heading them over but the pick soon works loose. Can these be welded so that they will stay?

A.—Coal picks can be welded to pipe handles and they will never work loose. A pick with a round hole will usually take a piece of $3/4$-in. standard-weight pipe. Drive the pipe into the pick until the end is flush. Using arc welding and a $5/32$-in. electrode weld a bead around the top end. Then stand the pick with the handle up and weld another bead around the other side. A piece of welding rod six or eight inches long fastened to the welding bench will hold the picks upright and enable the operator to turn them at will.

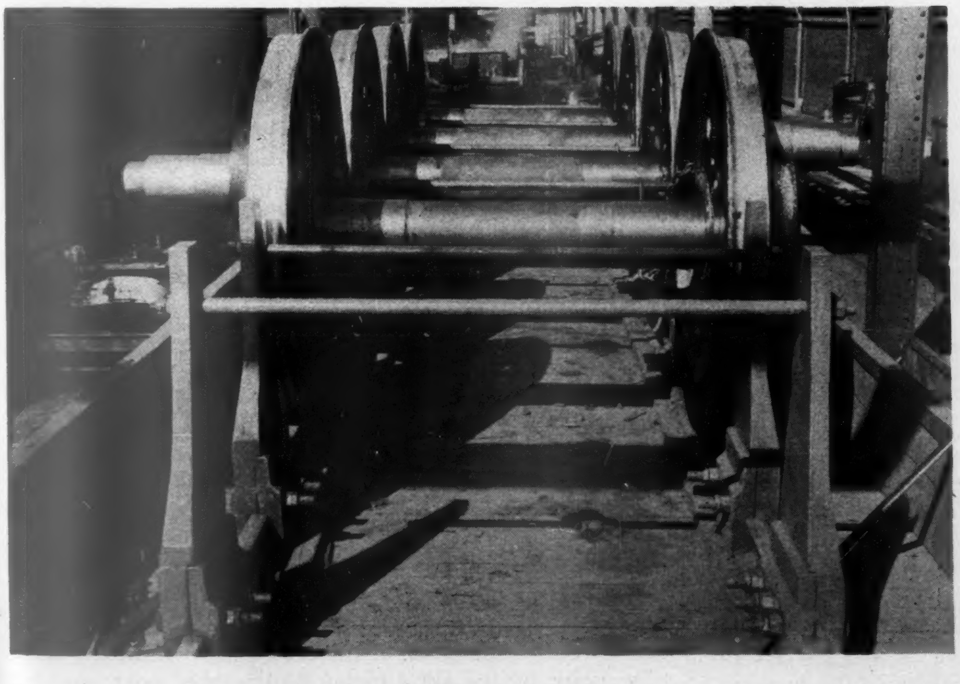
Driver-Wheel Handling Car

All heavy repair operations on locomotive driving wheels for the Louisville & Nashville are concentrated at the main repair shops, South Louisville, Ky., where machine equipment and other facilities are available for doing the work accurately, quickly and at relatively low unit cost. This method of operation, however, involves shipping worn or otherwise defective driving wheels from outlying points to South Louisville and then returning them after they have been repaired. For this movement of mounted driving wheels, the L. & N. has found the type of special gondola car, shown in two of the illustrations, to be most satisfactory.

Two rails of the proper length, with standard gage spacing, are securely mounted on the gondola car floor and carry relatively heavy and well-braced vertical steel spacing bars, which are adjustable on the rails and serve to separate the driving wheels and hold them firmly in position in the car. Experience with early shipments of driving wheels loaded in this manner shows the absolute necessity of firm anchorage of the bottom supporting rails to the car structure. In addition to being securely fastened to the car floor by bolted connections, small auxiliary anchor plates are welded at one end to the rail and at the other to the car underframe, thus preventing longitudinal movement of the rails on the car floor.

As an additional precaution in the interest of safety, the driving wheels are also chained together. The balance of the car not occupied by driving wheels is available for the shipment of driving boxes, spring rigging or brake rigging, etc., all of which goes on the same locomotive. A rectangular steel container, equipped with

The driving wheel press at South Louisville shops is equipped with an elevating platform to accommodate wheels of various diameters



The wheels are secured between adjustable separator bars

Gondola car equipped for the shipment of locomotive driving wheels on the L. & N.

rings for the attachment of crane hooks, is used in one end of the car for the easy handling of some of the smaller parts.

The large wheel press at South Louisville is equipped with a special elevating steel platform to accommodate wheels of different diameters without the use of cumbersome and relatively unsafe wood blocking. This platform consists of a steel frame mounted on four air cylinders set in the shop floor and interconnected so that one operating valve raises or lowers all pistons simultaneously. The steel platform carries a rail on either side which serves as a support for the cross channels which hold the wheel centers at the proper elevation while either wheel is being mounted on the axle. The device works equally well in all dismounting operations.

Locomotive Boiler Questions and Answers

By George M. Davies

(This department is for the help of those who desire assistance on locomotive boiler problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless special permission is given to do so. Our readers in the boiler shop are invited to submit their problems for solution.)

Operation of Fusible Plugs

Q.—When a fusible plug drops in the firebox does the plug itself drop or is it the fusible metal in the plug that lets go?—F. L. R.

A.—There are various types of fusible plugs used in locomotive fireboxes. A typical standard fusible plug is illustrated in Fig. 1. The fusible plug is made of bronze and it is screwed into the firebox crown sheet. It has a solid core of fusible metal which has a melting point of 400 to 500 deg. F. In case of a low-water condition the temperature of the crown sheet rises until the melting point of the alloy metal core is reached, the core melts and drops out and allows steam and water to enter the firebox. The plug itself remains in the crown sheet. Fig. 2 illustrates one of the many variations of fusible plugs in use. This plug is screwed into the firebox crown sheet in the same way as the plug shown in Fig. 1. However, this plug has an additional plug, or button, inserted in it

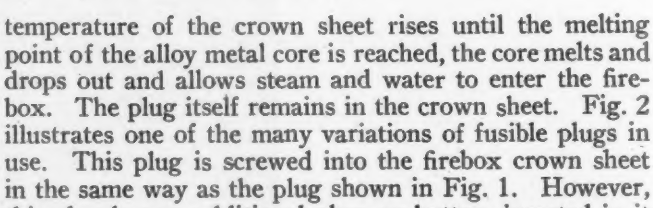


Fig. 1—(Left): A common design of fusible plug. Fig. 2—(Right): One of many variations

which is held in place with a fusible metal having a melting point of 400 to 500 deg. F. A low-water condition raises the temperature of the crown sheet until the melting point of the alloy metal holding the inner plug, or bottom, is reached, the alloy metal melts out and pressure on the inner plug causes it to drop. The plug itself remains in the crown sheet. This type of plug should function more rapidly because pressure is acting on the inner plug and, as the fusible metal reaches a certain degree of softness, the pressure on the inner plug forces it out of

the plug body. In no case is the fusible plug inserted in such a way that the plug itself drops.

Magnaflux Testing Of Locomotive Boilers

Q.—Will you kindly explain how cracks are found by Magnaflux method? Is this method applicable to locomotive boilers?—M. D. R.

A.—The Magnaflux method is a magnetic-dust method of discovering invisible cracks and defects. This dust is manufactured by the Magnaflux Corporation and is generally known as Magnaflux powder. It is a basically metallic iron that has been finely ground to pass a 100 mesh sieve.

The object to be tested must first be magnetized, the test is then performed by sprinkling the powder lightly over the area to be examined and then striking with a hammer to cause the powder to arrange itself and line up over any defects that are present. Where a crack exists in a magnetized area, the powder will attempt to bridge the gap between the two edges forming a distinct line over the crack.

The method could be applied to a locomotive boiler; however, it would hardly be practical due to the size of the boilers and the limited means of handling.

To inspect any surface, it must be positioned so that it doesn't slope too much or the powder will slide off and will not give good indications. When testing the circumferential seams or shell of a boiler, it would have to be turned as the testing progressed and only that portion of the seam or shell from which the powder did not slide off could be tested. This procedure would require that the boiler be revolved which would hardly be practical for a locomotive boiler.

To magnetize the boiler would also be a problem, requiring the winding of several turns of a flexible energized cable through or around the boiler. Longitudinal winding is preferred as it is a more efficient way of magnetizing.

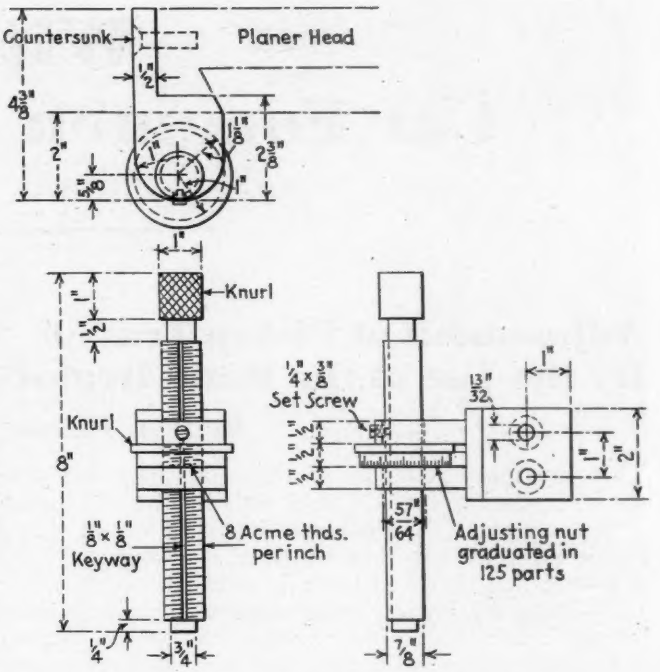
For examining a local condition, or small area, this method could no doubt be used on a locomotive boiler. The boiler would have to be placed so that the area to be examined was level.

The area to be examined can be magnetized by either of two methods; by magnetizing the area with a pair of portable electro-magnets, with the magnets about a foot apart, or by passing a heavy current through the area to be tested. This can be accomplished with an apparatus having two metal fingers set in an insulated handle and having no contact with each other. The contact points are pressed on the surface, the area between them is magnetized by the flow of current and the test is made while the current is on.

The area to be tested should be wire brushed and any scale or sediment removed. A perfectly clean bright surface is not necessary as the powder will reveal cracks through a light scale or rust coating, but it is desirable all loose scale or rust should be removed before applying the powder.

Micrometer Stop Block for Planer Head

In doing duplicate work on a planer or work near to a given thickness, the micrometer controlled, positive stop shown on this page is a definite labor saver.



Details of planer stop having micrometer adjustments

To start a cut, measure it and find that you have $\frac{1}{64}$ in. more or .015 plus to come off, and to be able to drop the head down exactly .015 in. run your cut across without measuring any more, and if the next part to plane

Micrometer planer stop mounted on planer head

is a given amount thicker or thinner you can raise or lower the tool the exact number of thousandths you want.

It is also very convenient in planing off-set surfaces. Do not confuse this with the micrometer dial on the feed screw. This is a positive stop with micrometer control.

With the Car Foremen and Inspectors

Adjustment of Piston Travel By the Use of the Hand Brake

*By P. J. Hogan**

There are many points on all railroads where cars cannot be reached with air to make tests for the adjustment of piston travel. The adjustment can be accomplished by the use of the hand-brake method as follows:

1—See that the hand brake is released.

2—Move the brake rigging slack to the piston lever by pushing the piston lever towards the brake cylinder.

3—Push the cylinder push rod back into the piston sleeve until it contacts the piston.

4—Mark the push rod outside the sleeve.

5—Set up a good tight hand brake.

6—Measure the distance from the mark on the push rod back to the sleeve, this will be the length of the piston travel.

If the car is equipped with the old Master Car Builders' brake shaft and wheel, add ½ in. to the distance found. If the car is equipped with a good geared hand brake, the distance found will be equal to the piston travel produced by the air brake method.

With the limited time usually available for preparing trains in departure yards, everything possible should be done to keep the piston travel properly adjusted on all cars in order to avoid delays.

The hand-brake method of adjusting piston travel is not new. I have used it for over 40 years. However, I fail to find many people making use of this convenient and helpful method.

* Supervisor car inspection and maintenance, New York, New Haven & Hartford, New Haven, Conn.

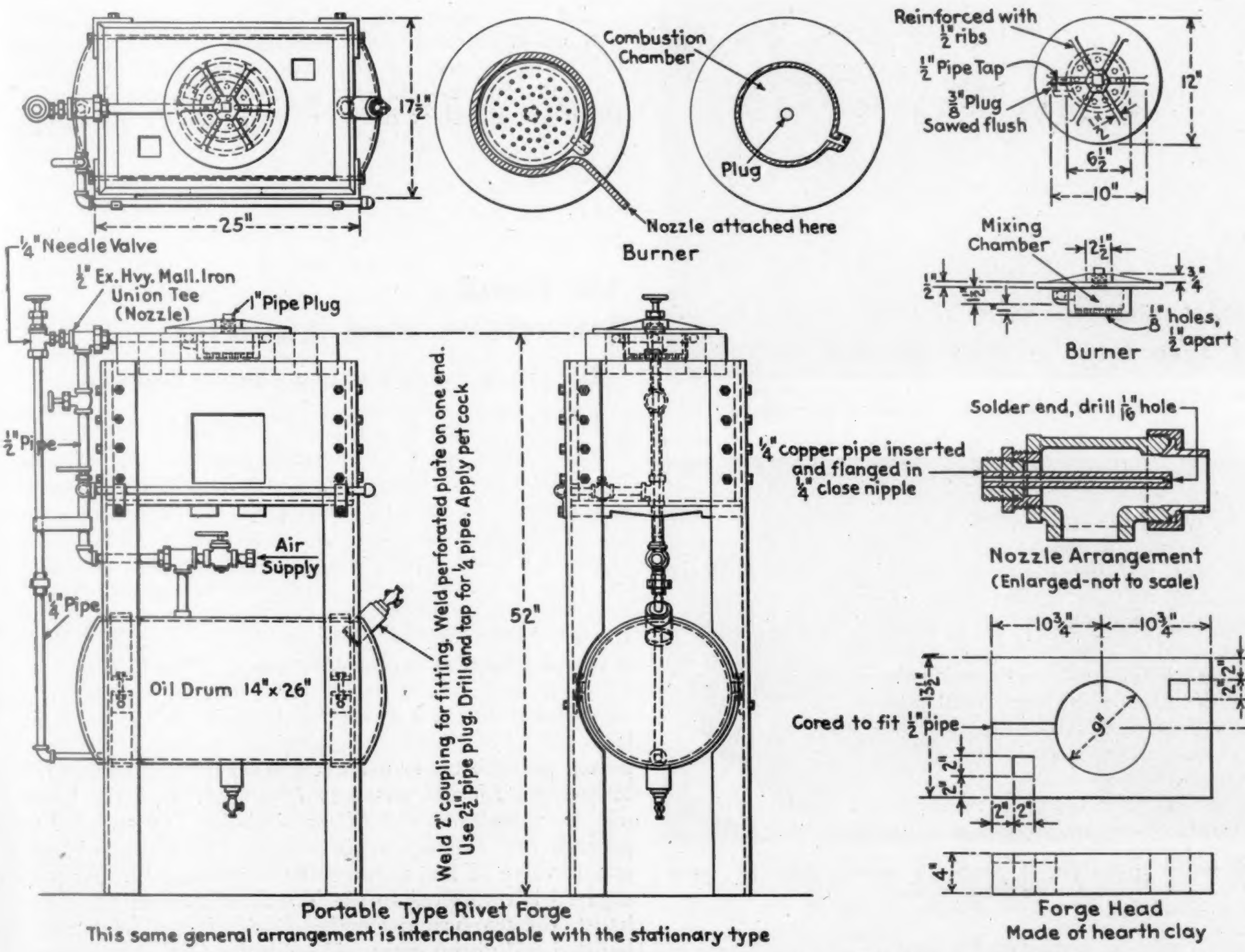
Rivet Heater With Improved Burner

The portable rivet-heating furnace, shown in the illustration, is equipped with a new and non-patented type of oil burner, developed at the South Louisville, Ky., shops of the Louisville & Nashville, which has shown unusually favorable results in service, both from the point of view of noise reduction and fuel economy. This burner may be applied equally well to larger stationary rivet heaters if desired.

The particular rivet heater illustrated is of the conventional type, 52 in. high, with an exterior furnace area of 17½ in. by 25 in. and is made of steel plates and 3-in. angle legs. The furnace itself is lined with firebrick in accordance with the usual practice and has a removable head made of hearth clay. The main fuel supply is carried in a 14-in. by 26-in. oil drum suspended between the furnace legs and arranged to be supplied with air pressure on top of the fuel oil from the same pipe line which carries air to the burner nozzle. A ¼-in. pipe line, connected to the bottom of the oil drum, conveys fuel to the burner by means of the pipe connections and ¼-in. needle valve illustrated. The usual air shield to protect the operator against heat from the furnace is supplied by means of the small perforated pipe on the front of the furnace.

The construction of the fuel burning nozzle and the improved burner are shown. The nozzle consists of a ¼-in. copper pipe with a restricted $\frac{1}{16}$-in. opening in one end, this pipe being supported in a ¼-in. close nipple and extending into the ½-in. malleable-iron union tee, provided for the first mixture of air and fuel particles. This mixture then passes through a short pipe section to the burner proper, which is inserted in a cavity in the clay head or top of the furnace. The burner consists of a gray iron casting with a combustion chamber in the center and small perforated holes extending from

Portable rivet-heating furnace developed at the South Louisville shops of the L. & N.



Rivet-heating furnace details, including nozzle arrangement and special burner construction

this chamber down to the furnace proper. The fuel delivery pipe makes one turn around the outside of the combustion chamber for preheating purposes and preliminary firing of the fuel takes place in the combustion chamber. The heated mixture of burning fuel oil vapor and air is forced downward into the main part of the furnace where combustion is completed quietly but at a high temperature.

The designs of this combustion chamber is such that the fuel oil and air mixture is baffled to a considerable extent and a very large proportion of objectionable noise, usually associated with the operation of rivet heating furnaces, is eliminated. In addition, it is said that this type of burner effects a fuel saving of at least fifty per cent as compared with other types formerly used at South Louisville shops.

Home-Made Clamping Table Speeds Welding Operations*

By Vernon Wainscott†

The process of welding comparatively small articles or irregularly shaped pieces of metal often proves quite exasperating as well as time consuming. Any welder can vouch for the fact that it is a common occurrence to spend 10 or 15 min. placing objects in just the right position for welding only to have them fall after gloves

A light blow of the hand sets the clamp firmly and holds the work piece in the desired position

have been slipped on and the welding helmet pulled down over the face. If, luckily, this does not happen and the welder gets to the point of applying the electrode, it may stick to one of the parts, and then the whole process must be repeated. Much valuable time and patience is expended.

To overcome the above difficulty, the writer devised a means of securely clamping the parts to be welded. This

* Abstract of a prize-winning paper submitted in the recent $200,000 Industrial Progress Award Program of the James F. Lincoln Arc Welding Foundation.

† Coach Repairman, Southern, Ludlow, Ky.

A lock lifter positioned for reclamation by welding

Angle-section frames can be clamped in position while the corners are being welded

method may be employed by anyone at negligible cost and in a few minutes.

The top of the welding table measures approximately 22 in. by 24 in. and, it is 2 in. in thickness. This piece of metal, retrieved from a scrap pile, contains two holes in each end, bored about 2 in. from the edge. The original use of the table top and the purpose of the four holes is unknown, but after numerous experiences with tedious welding jobs, a staybolt, to which a crosspiece had been welded at the top, was inserted in one of the holes as a brace against the part to be welded.

The thickness of the metal table top causes the bolt to bind and once the clamp is wedged in place there is no possibility of its slipping during the welding process. A slight tap with the heel of the hand, sets the clamp until the job is finished. To remove the bolt a blow with the fist is generally sufficient, although a rap with a hammer on the end beneath the table may sometimes be required.

Although the writer has found two or three clamps adequate for his purposes, there is no end to the possibilities for the use of these clamps. Any number of holes may be bored in the table top at various intervals, making it possible to brace, on one or both sides, any or all of the parts to be welded. The ends of each crosspiece or jaw pieces may be different lengths, thus providing a variety of clamps with a minimum number of holes. The ends may be of varied sizes, shapes, and thicknesses. For example, the clamp shown holding a lock lifter in position for welding might be more effective with a pointed end. Had the hole been slightly smaller, the blunt end could not have been inserted. With a metal-cutting band saw the clamp can easily be shaped to suit the needs of the Job.

The clamp leaves all objects in position to be welded from either side without interference. Pieces can be set at 80 deg., 70 deg., or almost any angle and held firmly. Unwieldy frames can be held in place for easy welding. The great advantage of this clamping table is the facility with which a welder may provide a clamp of his own design to suit his own particular need.

Air Brake Questions and Answers

HSC High-Speed Passenger Brake Equipment

140—*Q.—How do the F. S. 1864 and F. 1864 relay valves connect up in the charging position?* A.—At the F. S. 1864 relay valves on the cars having speed governors and the F. 1864 relay valves on the remaining cars, the supply reservoir air from connection *6* charges the chamber around application piston *30* and its pilot valve *32;* pipe *16* is open to the control valve, passages *16* and *16a,* past double check valve *228* to passages *8a* and *8* to the straight-air pipe which is open at the No. 21 B-magnet valve exhaust. This connects diaphragm chambers *P, N, K* and *A* of the relay valve through passages *19, 18, 17,* and *16a* to the magnet portion. With the M.S., L.S. and H.S. magnets deenergized, passage *19* is connected past the upper magnet valve *161b* and chokes *138* to passage *15,* and passages *18* and *17* past the lower magnet valves *161* and *161a* and chokes *140* and *142* to passage *15.* Passage *15* is connected past the unseated supply valve *92* and passage *16c* to passage *16.* As passage *16* is connected to the No. *21-B* magnet valve exhaust, the diaphragm cavities *P, N. K* and *A* are exhausted and piston spring *42* holds the diaphragm assembly released. All pressure is thus released from lever *43* which floats freely, permitting the exhaust piston *25* and its valve *23* to remain open, releasing the air from chamber *F* and connected brake cylinders to exhaust *Ex.*

141—*Q.—What takes place when a straight-air brake application is made on the power unit?* A.—When a brake application is made on the power unit, a master controller closes the application and release wires, thus energizing the coils of the application and release magnets on the No. *21-B* magnet brackets on each car (see wiring diagram Fig. 16). The armatures of the magnets are pulled down against the spring pressure beneath the valves; release magnet valve *62* is seated, closing off the straight air pipe exhaust passage *x* in each magnet bracket, and application magnet valve *34* is unseated, opening passage *6a* to *4b.*. Auxiliary reservoir air thus flows to the straight-air pipe, building up the straight-air-pipe pressure throughout the train.

142—*Q—How long does the flow from the auxiliary reservoir continue?* A.—Cut-off valve *5* of the *21-B* magnet bracket is held unseated by spring *17,* permitting the auxiliary-reservoir air to flow to passage *6a* as long as the auxiliary-reservoir pressure exceeds approximately 75 lb., which is the value of spring *10.*

143—*Q.—In the event of loss of auxiliary-reservoir pressure due to straight-air pipe breakage or abnormal magnet-valve operation, is there an effective pneumatic brake application available?* A.—Yes.

144—*Q.—What provides for such an emergency?* A.—Spring *10* will seat valve *5* of the No. *21-B* magnet and thus retain 75 lb. auxiliary reservoir pressure.

145—*Q.—In what position does the brake valve rotary on the power unit remain, for electro-pneumatic service applications of the HSC system?* A.—In charging position.

146—*Q.—This being the case, how do the brake-pipe and auxiliary-reservoir pressures compare?* A.—The brake-pipe pressure is higher on the face of the D-22 BR control valve service piston during applications of the HSC system than the auxiliary-reservoir air back of the piston, as the auxiliary air is reduced into the straight-air pipe at the No. *21-B* magnet valve.

147—*Q.—What position, then, do the service and emergency pistons remain in?* A.—In release position.

148—*Q.—To where does the air flow from the straight-air pipe?* A.—To the D-22-BR control valve, entering connections *8* and passages *8* and *8a,* and moving double check valve *228* to its right-hand seat, thereby sealing off passage *3,* which is open at this time through cavity *Q* of release slide valve *11* to exhaust passage *10.* Movement of the check valve uncovers passage *16a,* through which straight-air-pipe air flows to pipe *16* and thence to the F. S. 1864 relay valve.

149—*Q.—What occurs as the straight-air-pipe pressure is built up to the desired amount?* A.—When so built up (as controlled by the position of the brake valve on the locomotive), the master controller on the locomotive moves to lap position in which the release wire remains energized but the application wire is de-energized. The coil of the release magnet on the No. 21-B bracket is thus de-energized, and spring *35a* closes application magnet valve *34.* The release-magnet coil remains energized, holding release-magnet valve *62* seated, retaining the pressure in the straight-air pipe.

150—*Q.—What action takes place if the straight-air brake application is increased at the brake valve?* A.—Straight-air pipe pressure is increased an equal amount by the operation of the application magnet after which the magnet closes as before.

Building Up Worn Equalizer Ends

The method of repairing hook-type equalizers with worn ends, followed at the St. Louis-San Francisco passenger car shops, Springfield, Mo., is particularly interesting because of the ingenious oil-fired preheating furnace arrangement used. This furnace consists of a firebrick-lined steel box, 24 in. sq. and about 4 ft. long mounted on a steel framework which spans a track in the coach shops and is just high enough to clear the frames and wheels of two special pushcars which are designed to support the equalizers while being worked on.

The oil-fired furnace has a narrow opening at each end and reference to the illustration shows how it is possible to heat one end of each of two equalizers at the same time. After being suitably preheated, each equalizer is withdrawn from the furnace by moving the pushcar. An oxy-acetylene torch is used in applying just enough molten steel to build up the worn end of the equalizer to standard dimensions, this material being smoothed slightly by a hand hammer so that the equalizer fits the gage and no subsequent machining is required.

It will be noted that each equalizer is supported between a pair of vertical jaws which are tightened by suitable clamping bolts. These jaws are pivoted so that, when withdrawn from the furnace, the equalizer can be dropped to a horizontal position on either side of the central supporting posts which are themselves mounted on a baseplate designed to rotate about the pushcar center. This gives complete flexibility in handling the equalizers which may be readily revolved end for end, or dropped to a horizontal position on either side as required for the most efficient use of the acetylene torch. It is thus possible for the operator to work in building up one end of the equalizer while the other is in the furnace being heated.

One complete car set of equalizers can be reclaimed in less than half the time formerly required, to say nothing of the saving of about eight hours of machining time.

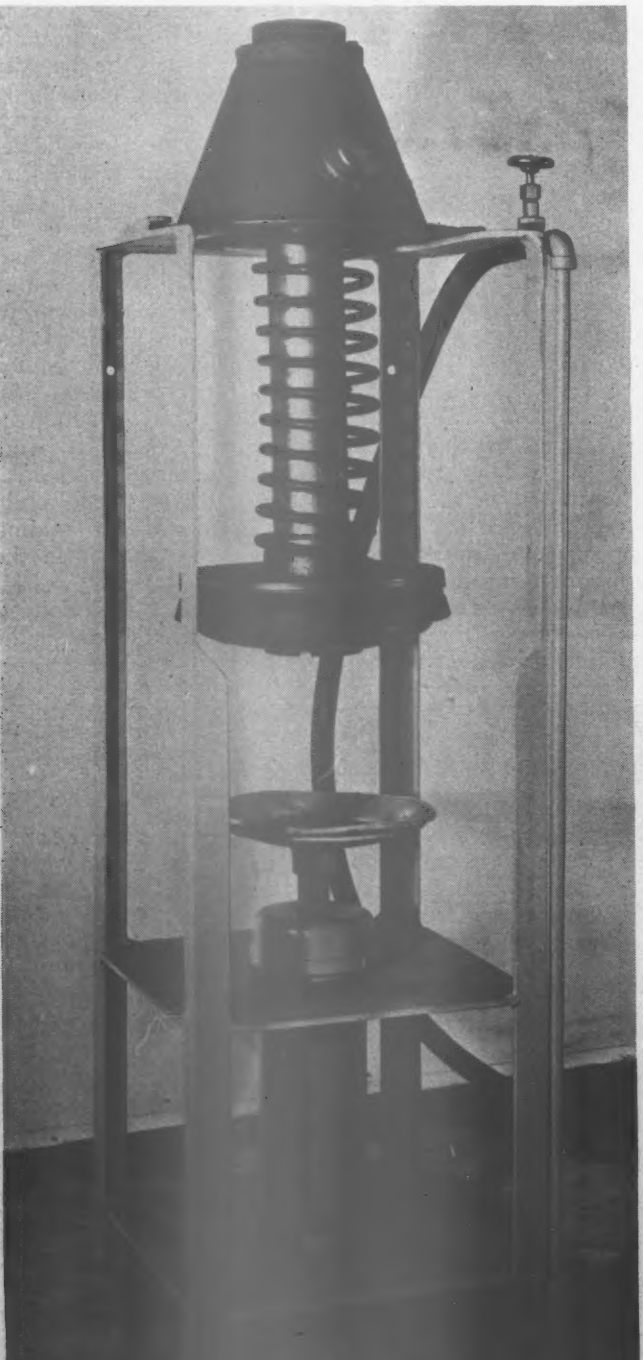
Furnace and special push cars used in building up worn equalizer ends at the Frisco passenger car shops, Springfield, Mo.

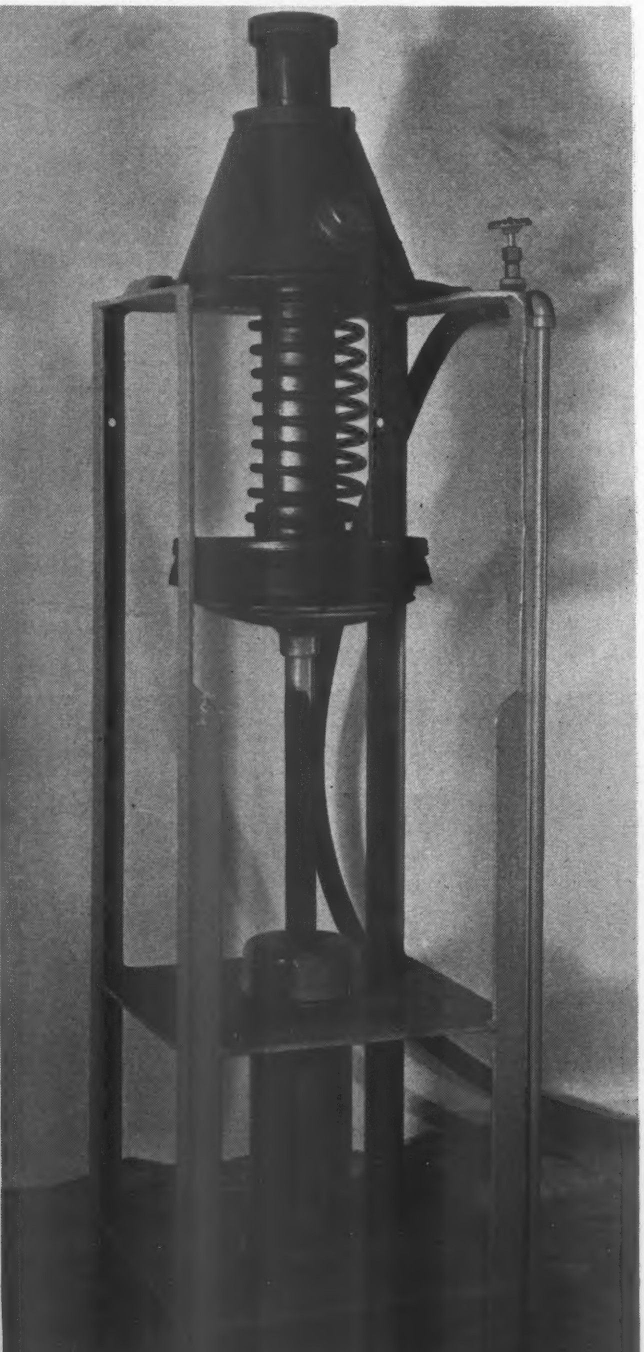
Device for Dismantling AB Brake Piston

An unusually neat and effective device for use in dismantling and reassembling pistons of AB freight brake equipment is shown in the illustration. It is a welded construction utilizing 2-in. angles for the 42-in. long corner posts and 16-in. sq. steel base plates, made of ⅜-in. stock welded to the corner angles and serving not only to tie the structure together at the bottom, but to support the operating cylinder which is made of 4-in. pipe with a small piston and piston rod having a 12-in. total travel.

At the upper end of the device a plate with a large U-shape opening is welded to the corner angles to support the AB cylinder head, which readily can be slid over it and held against upward movement by two lugs. The upper end of the operating piston is equipped with a steel disc and leather packing to overcome any tendency to slip when air pressure is applied to move the operating piston upward and bring the disc in contact with the AB piston. Admission of more air to the cylinder compresses the AB piston spring and raises the piston so that the upper holding pin and ring can be removed.

The total travel of the piston in the operating cylinder is 12 in. but only a few inches of the upper part of this travel is used to move the AB piston upward, this amount being ample to enable the repair man to remove the holding pin and ring. When this has been done, the





Device for dismantling AB brake pistons—Left: The cylinder head and piston in place—Right: Piston raised to permit removal of the holding pin and ring

release of air pressure from the operating cylinder drops the AB piston and spring the full 12 in., permitting the piston head to be slipped off the device, after which the piston and spring can also be lifted out. One flange of each of the two front corner angles is cut away at the top to facilitate this operation. In re-assembling the AB brake piston and head, the operations are reversed.

Speeding Up Car-Shop Drilling

The device shown has been developed and installed at the St. Louis-San Francisco car shop, Springfield, Mo., to speed up multiple drilling operations on structural shapes and stacked steel sheets. For this purpose it not only has proved very successful in increasing production but has contributed to accuracy.

Referring to the half-tone illustration, the general construction of the device is apparent. A cross girder has been applied between the two adjacent building columns which are spaced 18 ft. 8 in. apart. This girder is constructed of $\frac{3}{16}$-in. steel plates welded together to form a rigid and strong box section. It is 30 in. deep and the bottom plate is located $3\frac{1}{2}$ ft. above the floor.

Projecting from this main girder at a point about 7 ft. from the right hand column are two 10-in. I-beams approximately 6 ft. long which are welded in place and stiffened by suitable tubular diagonal braces. These beams are designed to support at their outer ends the vertical post of a Black & Decker high-speed air motor with double-swivel arm support to permit drilling anywhere within a radius of 3 ft. The air motor not only swivels about the vertical bar but is capable of adjustment vertically to suit the requirements of the work being drilled. The motor has a rated speed of 750 r.p.m.

The work to be drilled is supported on a push car, made in this instance with a 4-ft. wheel base and 15-in. flange wheels, but one or more cars of varying lengths may be used as required to support long car sills or other material which is being drilled. In the case of long work, a windlass, either hand or air-motor operated and shown at the left in the illustration, enables the drill operator to move the work to him easily and without leaving his position. A drill similar to the one shown is installed on the other side of the girder about 7 ft. from the left hand building column, thus giving complete coverage for drilling purposes over the entire area of the track, including 3 ft. on each side of the rails.

A particular feature of this drill is the provision for supplementing hand feed by air feed through pressure from a J-type slack-adjuster piston with an air-reducing valve which cuts the pressure from 55 lb. for $1\frac{5}{16}$-in. holes to 12 lb. for $\frac{1}{4}$-in. holes. The use of this air feed keeps a uniform pressure on the drills and speeds up production.

The maximum radius of the drill is 22 in. on the first arm and 15 in. on the second or a total of 37 in. swing altogether. In operation, the hand feed is used to bring the drill down to the center-punch mark after which the air feed is applied. The capacity of the machine includes drilling $6\frac{1}{4}$ in. of stacked sheets, but it can also be used to drill angles, channels, flat plates and other car materials.

This drill is used primarily on passenger-car work, but a similar design has been successfully developed for use in freight shops where hopper, coal and box cars are built. For accurate work, the rivet holes are drilled $\frac{1}{16}$ in. less than the finish diameter and then reamed out after the car sheets and structural shapes have been assembled, thus assuring accurate full-size holes in which rivets, when properly applied, have maximum holding power. Multiple sheets are drilled all alike and all correct, and no distortion of the material occurs as when sheets are punched.

High-speed drilling device developed and installed at the Frisco passenger car shops, Springfield, Mo.

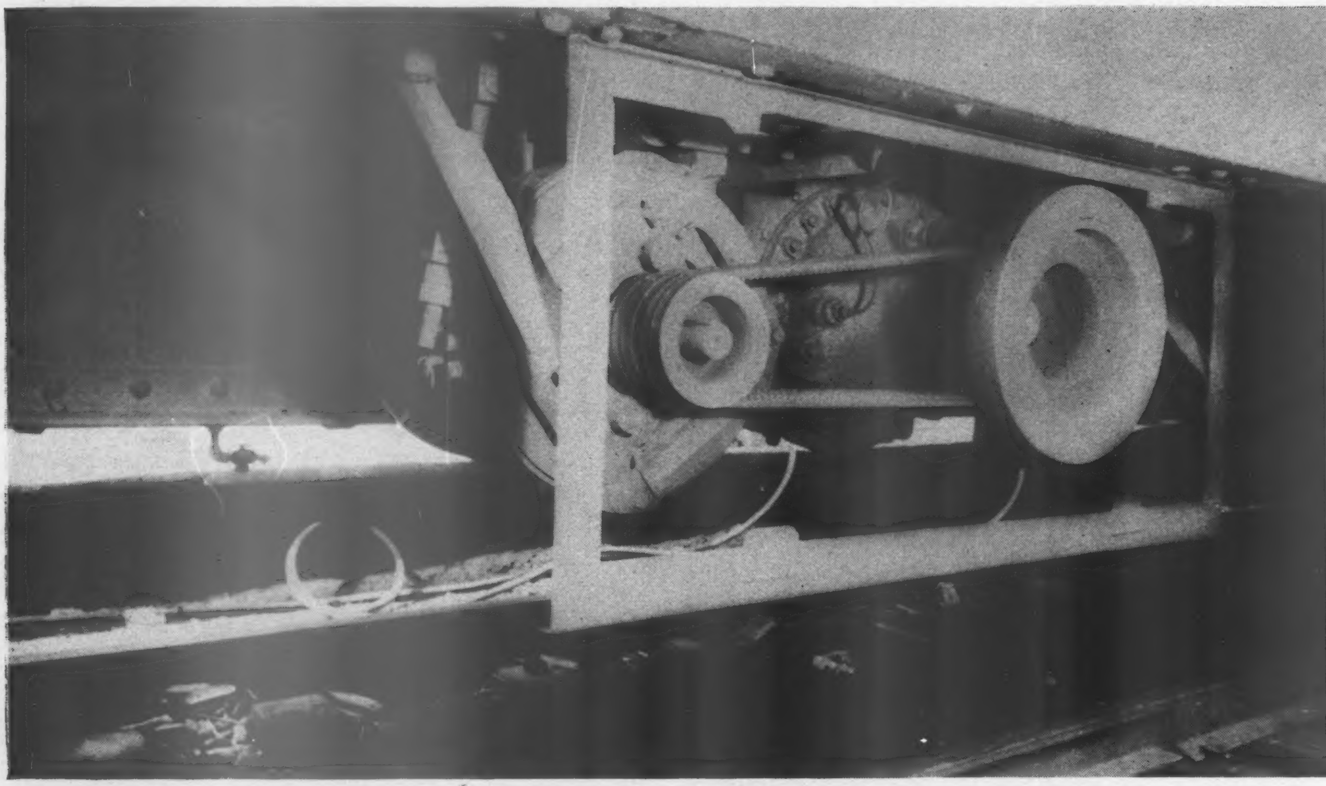


Fig. 1—Arc welded suspension with compressor and motor under a passenger car frame

Arc Welded Compressor Suspension*

THE Lundy Continuous Control air conditioning system was recently applied to eighty cars of one of our largest eastern trunk lines. (The initial installation was described in the October, 1941 issue of Railway Electrical Engineer.) The system is distinguished particularly by its use of a three-cylinder radial compressor which automatically operates on one, two or three cylinders, depending upon the demand for refrigeration. A study of the best method of suspending this compressor resulted in the design described in this article.

The purpose of the arc welded compressor suspension is to support the motor and compressor of the air conditioning unit under a railway passenger car frame, with provision for alinement of the motor pulley, for easy adjustment of belts to the proper tension, and for quick removal of the motor or the compressor for servicing.

Four types of construction were considered. Cast iron was discussed but eliminated as it was not acceptable to the railroad engineers, due to the danger of hidden defects and to the limited space available for the installation. Cast steel was acceptable but was found to be too expensive. Riveted structural sections and arc welded structural sections were considered and cost estimates were made resulting in the selection of the arc welded design.

The suspension consists of an all- arc-welded angle iron upper frame, 28½ in. wide by 53½ in. long, as shown in detail in Fig. 2, which is bolted to the under-structure of the railway passenger car. Due to the fact that the railroad engineers were very emphatic in their desire to have all connections of a positive nature, the frame was designed to rest on top of and be bolted to the under-structure of the passenger car with ⅞ in. bolts, as in Fig. 3, which shows the three angles of the car under-structure in dotted lines.

One of the interior angles of the frame, Part No. 24, shown on Fig. 2, is bolted to the suspension frame in order to more readily remove or replace the compressor, the feet of which rest on the upper side of angle irons, Parts Nos. 1 and 24, thus permitting ready removal or replacement of this unit for purposes of servicing.

The 10-hp. motor driving the compressor through a multiple V-belt drive is suspended on a pivoted base which is supported on the horizontal legs of angle irons, Parts Nos. 2 and 20, Fig. 3. This pivoted base consists of four motor arms, Parts Nos. 3, Fig. 5, the outer two of which are bolted to the frame, described im-

* Data and illustrations from a study submitted to the James F. Lincoln Arc Welding Foundation, by John F. Muller, sales engineer and Gonzalo C. Munoz, secretary-treasurer, American Pulley Company, in its recent $200,000 Industrial Progress Award Program for reports and advances and improvements made by the application of arc welding in design, fabrication, construction and maintenance.

mediately above, and have bushed bearings, Parts Nos. 10 and 11, welded to the inside of their semi-circular formed sections, Fig. 4. A piece of 1¼-in. diameter case-hardened cold rolled steel, supported by these two bearings, acts as the pivot for the motor. The two interior motor arms, parts marked No. 3, rest on the pivot rod through similar bearings and form the supports for the four legs of the motor.

The motor arm, Part No. 3, nearest the outer edge of the passenger car has welded to one end a tension rod pivot block, Part No. 7, to which is attached the adjustable tension rod, Part No. 3. The threaded lower end of this rod passes through a hole in the motor clip, Part No. 2. An examination of this part on Fig. 3 shows that by tightening this bolt the motor is caused to rotate around the pivot increasing the center distance between the motor pulley and the driven pulley on the compressor thereby tightening the belt. It is obvious, therefore, that through this device a service man may adjust the belt on this drive to the proper tension in a matter of a few seconds while the railway passenger car is stopped at a station.

The motor may be quickly removed for servicing by withdrawing the motor support pivot rod cotter pin, Part

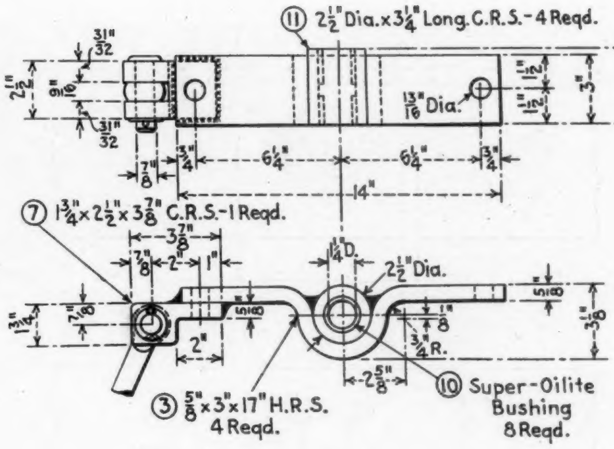


Fig. 4

Fig. 2 (Right)

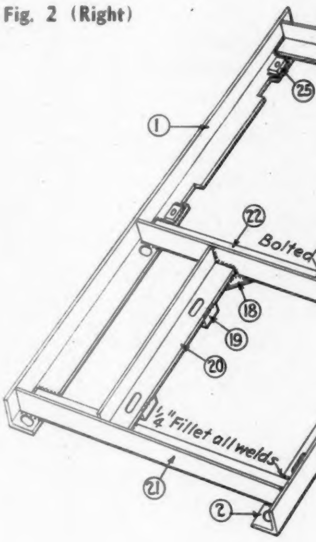
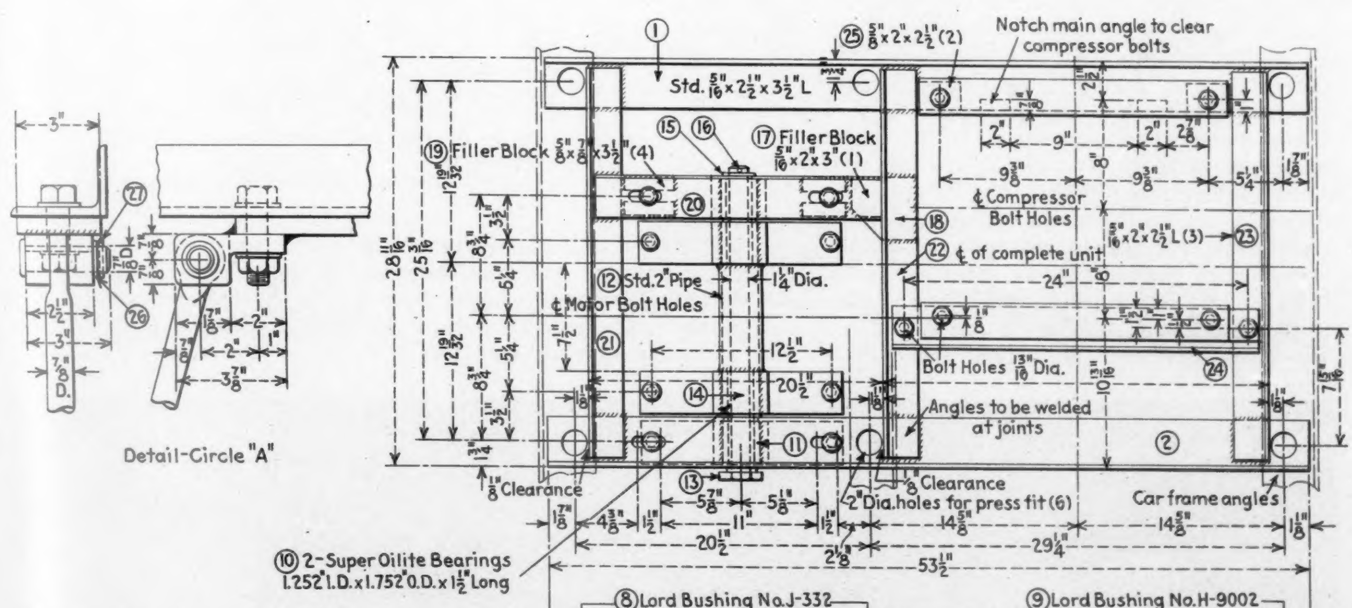


Fig. 3 (Below)



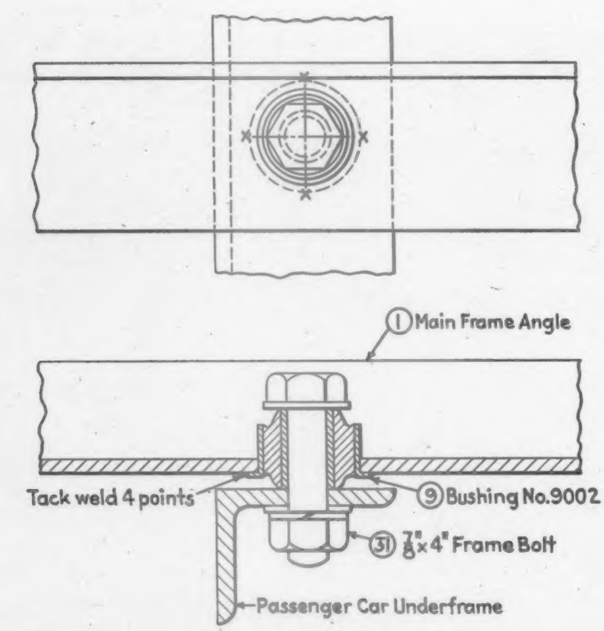


Fig. 5

No. 16; withdrawing the motor support pivot rod, Part No. 14; lowering the motor (to which two of the motor arms are attached) on to a dolly previously placed underneath; and removing the motor to the repair shop. The serviced or new motor may be replaced by carrying out the above operations in reverse order.

The three cross angle irons, Parts Nos. 21, 22 and 23, of the upper frame are designed to rest on the horizontal legs of the longitudinal angles, Parts Nos. 1 and 2, and be securely arc welded together to meet the requirements of positive connections insisted on by the railroad engineers. The six 7/8-in. bolts fastening the upper frame of the suspension to the underframe of the passenger car pass through tubular rubber mountings, as shown in detail in Fig. 5. The function of these mountings is to absorb the shock existing in all railroad rolling equipment, and also to prevent vibrations caused by the operation of the compressor from being carried into the body of the railway passenger car. Figure 3 shows slotted holes in Parts Nos. 2 and 20. These are for the four bolts fastening the motor arms, Parts Nos. 3, to the upper frame, and provide adjustment for belt alinement between the motor and the compressor.

The following is a complete parts list of the arc welded design:

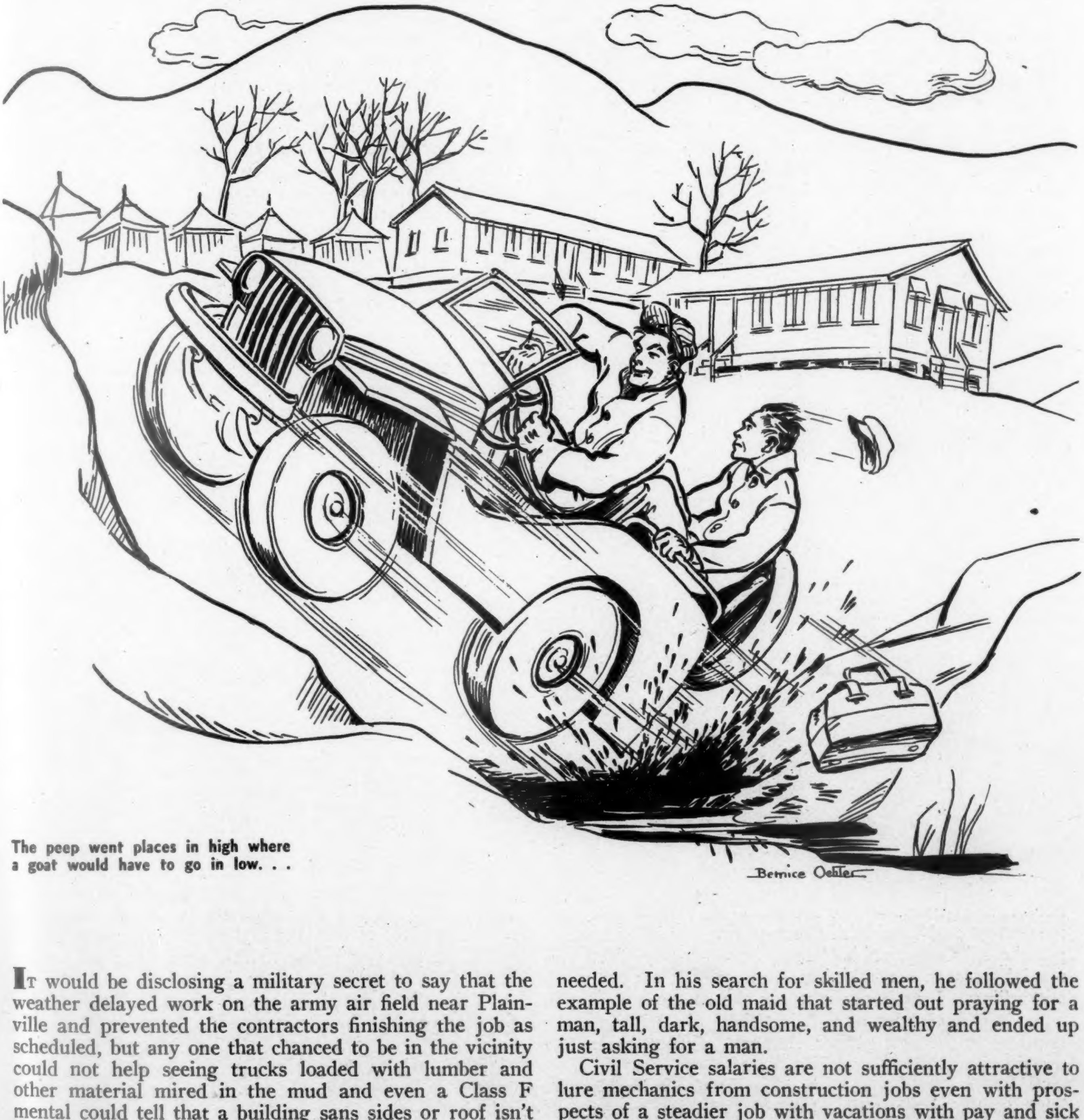
Part No.	Description	Number Required
1	Main frame angle (compressor side)	1
2	Main frame angle (motor support side)	1
3	Motor arms	4
4	Motor clip	1
5	Adjustable tension rod	1
6	Tension rod pivot pin	1
7	Tension rod pivot block	1
8	Lord bushing #J-332	4
9	Lord bushing #H-9002	2
10	Super-Oilite bearings #S-1701-S	8
11	Bearing retainer 2½ in. diameter by 3½ in. long. C.R.S.	4
12	2-in. pipe spacer	1
13	Motor support pivot rod end cap	1
14	Motor support pivot rod	1
15	Motor support pivot rod washer	1
16	Motor support pivot rod cotter pin	1
17	Filler block 5/16 in. by 2 in. by 3 in. H.R.S.	1
18	Gusset plate	1
19	Motor arm spacer blocks 5/8 in. by 7/8 in. by 3½ in. H.R.S.	4
20	Intermediate angle, motor arm support	1
21	Motor end cross angle 5/16 in. by 2 in. by 2½ in. by 27¼ in. angle	1
22	Intermediate cross angle 5/16 in. by 2 in. by 2½ in. by 27¼ in. angle	1
23	Compressor end cross angle 5/16 in. by 2 in. by 2½ in. by 27¼ in. angle	1
24	Intermediate compressor angle 5/16 in. by 2 in. by 3 in. by 25¾ in. angle	1
25	Compressor spacer blocks 5/8 in. by 2 in. by 2½ in. H.R.S.	2
26	Tension rod pivot pin washer	1
27	Tension rod pivot pin cotter pin	1
28	¾-in. by 2-in. bolts and nuts with lock washers	2
29	¾-in. by 3½-in. Hi-Tensile bolts and nuts	8
30	7/8-in. tension rod nuts	3
31	7/8-in. by 4-in. frame bolts and nuts	6
32	¾-in. by 2-in. by 2-in. spacer blocks H.R.S.	4
33	7/8-in. by 2-in. by 2-in. tapered washers, malleable iron	4
34	¾-in. by 2½-in. bolts and nuts with lock washers	4

(The remainder of the prize paper includes detailed design and cost data which show how the suspension described is better than one of riveted construction and calculates the cost of the welded suspension when made in quantity.)

Fig. 6—Interior of a passenger car equipped with step-modulated air conditioning

ALL UP IN THE AIR

By Walt Wyre



The peep went places in high where a goat would have to go in low. . .

It would be disclosing a military secret to say that the weather delayed work on the army air field near Plainville and prevented the contractors finishing the job as scheduled, but any one that chanced to be in the vicinity could not help seeing trucks loaded with lumber and other material mired in the mud and even a Class F mental could tell that a building sans sides or roof isn't quite complete.

Finished or not, the soldiers began to arrive on the designated date and that's where the story starts.

Captain Scott, post engineer for the field, arrived in Plainville about three weeks before the field was to be occupied to organize his maintenance force and see that at least a portion of the buildings were in readiness for the troops.

Working through the local U. S. Employment office, Captain Scott employed three stenographers, opened up a temporary office, and let it be known that mechanics and laborers of many and varied classifications were needed. In his search for skilled men, he followed the example of the old maid that started out praying for a man, tall, dark, handsome, and wealthy and ended up just asking for a man.

Civil Service salaries are not sufficiently attractive to lure mechanics from construction jobs even with prospects of a steadier job with vacations with pay and sick leave. The Captain did manage to find a competent carpenter who accepted the senior job because his home is in Plainville and he didn't want to leave. He also found a plumber who was forced to go out of business in a small town nearby because in the town, which had no defense project, material was almost unavailable.

Several electricians, would-be and otherwise, asked Captain Scott about jobs. The salary mentioned discouraged most of them and qualifications required bluffed others. "The chief electrician must understand maintenance of motors, automatic controls, inside and outside wiring, both high and low voltage, and should be familiar

with refrigeration," the captain told the first few that inquired about the job. After the first few days there were no more inquiries.

About ten days before the date troops were scheduled to begin to arrive, the post engineer and his chief engineer went to inspect the headquarters building, a mess hall, the telephone building, and a block of barracks that were, according to the contractor, ready for use with perhaps a few small jobs that would be taken care of. Here are a few of the conditions the engineer found: Wiring was complete in headquarters, but the lights wouldn't burn; only one of the two refrigerating machines in the mess hall would run and the branch circuit panel had not been received, all circuits were temporarily connected through the entrance switch and a hundred and one other odd jobs, one or more in almost every building.

"We must have a chief electrician," Captain Scott said, "and at least one junior electrician. See if you can't find one," he told the chief engineer.

Some one told the chief engineer that Ned Sparks, electrician for the S. P. & W., might be persuaded to take the job. Captain Scott called Sparks by phone and asked him if he would accept.

"I might," Sparks said, "if I could do it without losing my rights on the railroad. I'll be needing a job after this thing is finished. I'll come over and talk to you," Sparks added.

"Several people have told me that you are well qualified for the job as chief electrician," Captain Scott told Sparks.

"Well," Sparks replied, "I don't know about that. I've been keeping some other electricians off at least one job about thirty years."

"There doesn't seem to be any other electrician in this case," the captain said, "and we really need one."

"It's like I told you over the phone," Sparks said. "I wouldn't mind taking the job if I could protect my seniority on the railroad."

"How soon could you start?"

"Oh, in about fifteen days."

"O. K.," the captain said, "I'll write a letter to the railroad company and request them to release you, at least long enough for us to get some one else. I believe they will do it."

Next day Sparks talked to H. H. Carter, master mechanic on the Plains Division. "The railroad has to keep running, too, or else the army can't get where they need to go and wouldn't have anything to use when they got there," Carter said. "They have already hired half my laborers, two machinists, and several helpers without asking. I can't say whether the company will give you leave of absence or not, but they might if the army requests it through proper channels. When were you figuring on going to work out there?"

"Well, I was figuring on going in about two weeks. That would give me time to get everything pretty well lined up here. The other electricians should be able to keep things going and if you need any help Captain Scott said I could come any time."

"We can manage somehow," the master mechanic said, "but I don't see how if defense jobs and the army keep taking our men. Anyway, tell Captain Scott that if it isn't settled about you getting leave by the time you are supposed to go to work, you can go ahead and help him out at least while we are waiting to hear."

The matter had not been settled two weeks later when Sparks reported to the post engineer at the air field. "You are just in time," the post engineer said as he picked up a map big enough for a tablecloth. "These buildings I have marked are to be ready for use tomorrow. Check all of the electrical equipment and put bulbs in all sockets. The chief engineer will let you have a couple of men to help put the light bulbs in, and whatever you do, see that the officer in charge of each building signs for the bulbs in it."

The "light bulbs" (lamps) were issued to the electrician from the storeroom on a memorandum receipt. The storekeeper would give Sparks the receipt in return for tally out sheets signed by an officer for the bulbs.

The chief engineer gave Sparks a specification sheet showing the size and number of lamps to be used in each type of building. He also let him have two men to help as the Post engineer had promised.

Sparks worked out a system for the job. The two men were to put in lamps while the electrician checked any other electrical equipment and kept track of the lamps. But the system didn't provide any method of locating the officer that was to sign the tally out sheet or getting him to sign after he was found. Invariably the non-com in charge, usually an old timer well versed in the art of passing the buck, not only for himself but for his commanding officer, would say "Lt. Blank just stepped out, leave the tally out sheet and he'll sign it when he comes in" or something similar.

At noon Sparks reported to the chief engineer. "Bulbs in all barracks in block twenty-three except some of them don't have all the sockets hung and the refrigerating machine won't run in the mess hall. The mess sergeant said he was expecting a lot of meat this afternoon." Sparks added.

"Did you get all of the bulbs signed for?" the engineer asked.

"No, I couldn't find the officers."

"Well, the first thing this afternoon, get all the bulbs signed for," the engineer said, "and don't leave any more that are not signed for."

"What about the refrigerating machine?" Sparks wanted to know.

"See about it as soon as you get the tally out sheets for the bulbs signed."

After lunch Sparks went back to block twenty-three. "No, Lt. Blank hasn't returned, but I'll see that he signs as soon as he returns," the sergeant at the first barracks told him and it was the same at each of the others.

By two-thirty Sparks was so disgusted he was about ready to go tell the post engineer to tie the job up in a nice long piece of red tape and ram it in a rathole.

"What are you going to do now?" one of the men helping the electrician on the job asked.

"Take the damned bulbs out and take them back to the storeroom," Sparks snapped. "Start in at the first barracks."

"Hey, what's the idea?" the sergeant in charge wanted to know when the two men started screwing the light bulbs out.

"From now on I'm not putting in any bulbs until *after* they are signed for," Sparks said.

"Wait a minute, I'll see if I can find the Lieutenant," the sergeant said.

"I'll wait just five minutes," Sparks snapped, "and if I have to take the bulbs out, somebody else can put them back."

The sergeant dashed out the door and returned in less than five minutes. The lieutenant is coming right over," he said.

"Go down the line to the other buildings," Sparks told his two helpers, "and tell the non-com in charge that if

the tally out sheets are not signed when I get there, we'll take the bulbs out."

"What's all the fuss about signing for a few light bulbs?" Lt. Blank asked angrily, "and what's this about taking them out?"

"That's correct," Sparks replied. "That's my order and you should know what an order means."

"O. K.," the lieutenant grinned. "Light bulbs have a habit of disappearing and nobody likes to sign for them. Wish you would put an outlet by the desk for a desk light when you have time."

IT didn't take long for word to get around that the new chief electrician wouldn't leave light bulbs that weren't signed for and that ended most of the trouble of that kind.

About four o'clock Sparks went to the mess hall to see what was wrong with the refrigerating machine that wouldn't run. The motor, three-phase two-twenty volt, hummed as though on single phase when turned on. Sparks fixed up a test light using two sockets in series and tested the lines. On one phase the two 110-volt lamps were normally bright but only glowed red on the other two.

The chief engineer came in while Sparks was testing. "What seems to be the trouble?" he asked.

"Looks like low voltage on two phases," Sparks told him. "Maybe a transformer fuse blown."

"The linemen changed a transformer on the pole outside yesterday," the mess sergeant who was watching and listening said.

That gave Sparks a clue and he went outside to look at the transformer connections. He had considerable difficulty figuring out just how the transformers were connected at first. It is a Y system with a common ground as used by the R. E. A. He finally figured that when the transformers were changed,—a new pole had been set also which necessitated changing all secondary connections,—that the lineman had by mistake connected one of the three phase wires to the neutral of the 110/220 lighting circuit.

"I'll go tell the line construction foreman," the engineer said. "That's his trouble until we take it over. You go over to the hospital and see what the trouble is there. They are opening part of it and Major Johnson phoned that he wanted an electrician right away."

"OUR X-ray machine just came in," Major Johnson, the chief medical officer, told Sparks and the man that came to install it says the wires are too small. I have an extension telephone I'd like to have connected and there's something wrong with the lights in my office."

"I'll see about the wires to the X-ray machine and the lights, but I don't know about the telephone."

"Oh, it's not much of a job to connect the telephone. It's a brand new desk set the signal officer let me have. He said it wouldn't be much trouble to connect it." The major turned and left before Sparks could explain that he had only recently learned to operate a dial telephone and his experience with the other kind had been limited to talking a little and listening a lot.

Trouble with the lights in the office was soon located. The days being chilly, someone had brought in an electric heater that took 20-amps. and had blown the 15-amp. fuse plugs. Sparks then went into the X-ray room. He found a man in charge with three soldiers setting up the machine.

"You see the specifications call for number four wire," the X-ray man said, "and the wire to the switch is only number 6."

"I imagine that's up to the electrical contractor," Sparks said. "I'll see what the post engineer says about it and let you know in the morning." And so ended Sparks' first day at the air field. It was nearly two hours past quitting time when he reached the office, so tired his rear end was close to the ground as a daschund's belly.

Next morning the post engineer told him to go ahead and connect the telephone and to see the electrical contractor about the wiring to the X-ray machine. The contractor sent one of his foremen with Sparks to see about the wire.

"We didn't have any No. 4 wire when that was run," the foreman said, "and I figured six would be O. K. If we have to put in four, we'll have to run new conduit."

"How long will that take?" the X-ray expert asked.

"Oh, it might be three or four days," the foreman told him. "We've got a lot of work finishing up buildings that are to be used right away, and I'm not sure we've got any No. 4 wire."

While the two were talking, Sparks was examining the machine and particularly the electrical connections. He noticed that while there were three wires coming to the entrance switch, the X-ray machine only showed connections for two wires.

"Do you need 110 volts and 220 both?" he asked the expert.

"No, it is 220. Why?"

"Tell you in a minute." Sparks went outside and checked to be sure the machine was on a separate circuit, then back to the X-ray room.

"You don't need the neutral wire," Sparks told the electrical foreman. "Why can't you pull it out and pull in two eights and parallel an eight and a six for the two-wire circuit?"

The electrical foreman and the X-ray expert stood a moment looking at each other, then the foreman said, "That would give plenty capacity, a little more than two four's would."

"Well," the X-ray man squinted one eye as though aiming a gun, "I guess that would be O. K. All I want is to be sure the voltage drop isn't excessive."

"Buy you a drink the first time I see you in town," the electrical foreman said to Sparks as he left.

THE next thing on the program was the extension telephone. Sparks went into the office to see what it looked like. It was a desk set without the ringer, just the combination receiver and transmitter and the cradle, when Sparks saw the dial on the cradle he knew he didn't even know how to start connecting the phone. But looking at it wouldn't help, so he headed back to the storeroom and got fifty feet of twisted pair wire and some insulated staples and returned to the hospital.

He ran the wire; that didn't take long, then started trying to figure out how to connect them. He connected the two wires to the two that came into the phone that was already in service, then by the trial and error method started figuring how to connect the extension. He would connect to two binding posts, then try the phone. He kept that up until the operator had a "go to hell" tone of voice when she said number, without the please.

At last Sparks managed to get the wires properly connected so the extension would work, but of course lacking a bell it wouldn't ring. Sparks explained it to Major Johnson.

"That's fine," the major said. "I wouldn't want it ringing in here all the time. A buzzer with a push but-

(*Continued on page 59*)

CONSULTING DEPARTMENT

Correcting Overloads on Conductors

A feeder of the largest size possible to pull into a conduit is heavily overloaded and it is feared that the code rubber insulation is deteriorating rapidly. To replace the conduit which is buried below a concrete floor will be costly and interfere with production. What is the most economical way of correcting this condition?

Practical Things to Consider

Since any permanent correction of this condition likely will require apparatus and materials available only after long delay, if it is really feared the insulation is being damaged by excessive heating of the conductors, I suggest taking immediate steps to reduce the conductor and insulation temperature. This might be accomplished in two ways: namely, by installing a temporary, alternate or parallel circuit or by cooling the present circuit. An alternate of parallel circuit might be installed on timbers or it might consist of conductors or a cable laid on or just under the ground surface, carried over walks, roads, etc., protected by wood guards or by steel arches and run under rails between ties. Cooling of the present circuit might be accomplished by flowing water through the raceway or by creating a flow of air through it, using a blower or a compressed air jet. I recommend the use of water when practicable. An air flow induced by a compressed air jet may result in condensation in the raceway. If condensation fills the raceway at some point, pressure will be required to continue the air flow and care should be exercised if air is to be used under pressure. A pipe tee and nipple slipped over the circuit conductors and the nipple sealed will permit introducing water or air into the raceway through the side opening in the tee. Using water, if the two ends of the raceway do not differ in elevation sufficiently to provide an adequate flow, I would recommend piping from the side opening of the tee to an elevated funnel or discharge cone. This will permit using water under a fixed head rather than under pressure. It will be found a small flow of water is adequate. Although the above suggestions are unconventional, they will accomplish the desired results. Their use may be considered warranted to avoid failure of a vital circuit and to avoid ruining critically scarce conductor copper and rubber insulation.

Following are some permissible permanent solutions that may be used individually or in combination, depending on circumstances and the existing conditions:

(1) Assuming this is an alternating-current circuit, if it feeds a low power-factor load, power-factor corrective measures may relieve—and perhaps even completely correct—the condition. Since power-factor corrective measures have been presented in previous issues of this magazine, since they may be investigated by studying manufacturers' application data and reference works, and since manufacturers' engineers may be "called in" or consulting engineers retained, and because even a brief resume of available methods would lengthen this answer unduly, I shall not include any suggestions as to how power-factor can be corrected. I do desire to point out that, if underloaded motors are causing the trouble, corrective measures should include consideration of exchanging motors to more fully load the motors finally applied.

(2) If it is possible to measure or estimate the conductor and insulation temperatures at the hottest point, it then can be determined whether there is available a conductor insulation suitable for operation at that temperature. If so, conductors of the same size insulated therewith might be installed in lieu of the present conductors. If the hot-spot temperature is an unknown, reference to manufacturers' data on maximum current-carrying capacities of conductors with various insulations under the conditions obtaining in this installation will indicate what benefits may be anticipated if a different insulation is used. Since the overloading is severe, it likely will be necessary to use this scheme in conjunction with one of the others to completely correct the condition.

(3) There are several possible solutions involving use of a higher voltage. I shall separate these into two general classes: (a) If the circuit operates at 240 volts or less, the condition might be corrected by operating the circuit at 480 or 600 volts. If the present voltage is 480, although changing to 600 volts may relieve the condition, a complete correction likely will necessitate using this method in conjunction with one of the other schemes. Changing to a higher secondary voltage will require either reconnection of the transformer secondary leads feeding the circuit or replacement or installation of transformers. It also will require transformers at the load end of the feeder circuit unless the load can be reconnected readily to operate at the higher voltage. If the latter course is pursued, it will require replacement of distribution panels, circuit disconnecting means, overcurrent protective devices, controls, etc., with similar apparatus having the higher voltage rating. Considering the apparatus and materials required for such a change, if there are many utilization devices the use of transformers at the load end of the circuit no doubt will prove simpler, cheaper and a quicker solution. Additional disconnecting means and overcurrent protective devices probably will be required if the voltage of the circuit is increased. (b) If the circuit operates at 600

Can you answer one or more of the following listed questions? Suitable answers will be considered as contributions and will be published in a subsequent issue. If you have questions to ask, send them in also. Answers and questions should be addressed: Editor, *Railway Mechanical Engineer*, 30 Church Street, New York, N. Y. Answers to the following questions should be sent in not later than the 15th of February.

Some time ago we installed a conduit system in an enginehouse which we tried to make as tight (moisture-proof and vapor-proof) as possible. As soon as cold weather came on, all the low places filled with water and we had to drill holes to let the water out. What is the best way to take care of a situation like this?

What can I do to get the best service and longest life from the evaporators and condensers in our air-conditioned cars?

What is the best and easiest way to find whether an oxide-film rectifier is shorted or operating properly?

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volts or less, changing the circuit to 2400 or 4150 volts or to primary distribution voltage might be advisable. This will require replacing the present conductors with conductors having high voltage insulation. The circuit then may be connected to the primary distribution system or to a transformer installed to provide the higher voltage. This change will require a transformer at the load end of the feeder circuit for reduction of the circuit voltage to utilization voltage. Also, the installation of additional disconnecting means and overcurrent protective devices in the primary and secondary circuits may advisable.

Transformers used in connection with the changes suggested under (3) should be non-inflammable, liquid-filled or air-cooled, agreeable with National Electrical Code and other Standards, if they are mounted within or adjacent to buildings.

Although the inquirer requested the most economical solution of the problem, the general statement thereof demands a general answer. It does not permit an analysis of the economy of the solutions suggested. I have listed, therefore, the more likely methods that might be applicable in relieving or correcting the condition. The inquirer should estimate the cost of each applicable scheme or combination of schemes that will correct his conditions as they actually exist. The proper procedure then may be determined on the basis of those data evaluated against estimates of energy losses and maintenance expense for each solution and of the anticipated future load growth, etc. The final choice will have to be adjusted to the availability of the apparatus and materials required for each solution that will correct the condition.

P. O. Lautz,
Electrical assistant,
Atchison, Topeka & Santa Fe Ry. Co.

Before Making Corrections, Look for Faults

The fact that a feeder is overloaded may not be due to faulty conditions, but it seems reasonable to look for trouble whenever any electrical equipment is overloaded.

If the circuit feeds induction motors or fluorescent lamps, the trouble may be traced to a poor power factor. Capacitors will correct this condition. If the load is unbalanced, the thing needed is a careful balancing. In this connection, it is well to remember that induction motors pull unbalanced loads if coils have been cut out of some of the phase windings. Also, motors often pull excessive loads due to mechanical trouble on the driven machine. A careful check of gear alinement, lubrication, condition of cutting tools, bearings, etc., should clear the slate of most mechanical ills. It also might be well to look for grounded equipment. Two separate grounds located in different parts of the same shop can cause strange circulating currents. Grounded conductors will usually show up by the blowing of fuses or the opening of circuit breakers, but grounds in motor windings may go undetected for long periods unless a special effort is made to find the trouble.

If the overload cannot be decreased by the elimination of trouble, then it will be necessary to take other steps. Wire with special heat resistant insulation could be installed, or wire with thin insulation might be considered. The latter will allow a greater amount of copper in the same sized conduit, and thus might reduce the heating.

If, due to war conditions, it is impossible to obtain special wire, then it may be necessary to resort to some makeshift arrangement. Under this heading might be considered the use of an air blast directed down the conduit to keep the wires cool. If the circuit is of the two-wire direct-current type, then the two wires in the conduit could be paralleled to provide the positive leg of the circuit, while the negative leg is carried through building steel, or through bonded rails located in the vicinity. If this last method is used proper care should be taken to avoid electrolysis due to leakage from the return path.

Ford C. Pethick,
Assistant electrical supervisor
Delaware, Lackawanna & Western

Six Ways to Reduce the Temperature

(1) Overheating of the feeder may be caused by low power factor. Check with instruments for power factor of feeder and of principal loads that may be causing the low power factor. Connect capacitors at or near the loads that are causing the trouble. Aim to get 0.90 or 0.95 power factor. If the feeder tests 0.90 p.f. or better, capacitors will be of little help.

(2) Investigate the loads on this feeder and on other feeders. Perhaps some load can be transferred to some feeder which is underloaded and which has high power factor. This may involve moving the driven equipment or installing long conductors to reach the other feeder.

(3) Investigate the larger induction motors if there are any on this feeder. A unity p.f. or 0.80 leading p.f. synchronous motor or two may be substituted. This latter expedient will have a double effect—it eliminates the lagging reactive kva. caused by the induction motor and adds leading reactive kva. from the synchronous motor.

(4) If the power factor is good, then perhaps the voltage may be stepped up, say 15 per cent, by auto-transformer with consequent reduction in current and heating. If the connected load will not stand the voltage increase, a step-down transformer at the other end will restore voltage to normal at the loads.

(5) See if some loads can be transferred to night operation or to some other off peak time so as to reduce the feeder load.

(6) A power company has reduced heating successfully by running city water through conduits certain hours of the day when heating runs highest.

R. H. Rogers,
Industrial Engineering Department
General Electric Company

Examine the Load and Maintain Voltage

In plants where the national emergency has taxed all available equipment and supply systems beyond limits expected at the time of the original installation, means must be devised to utilize as much as possible the existing facilities in meeting the increased production demands. In raising the supply capacity of feeders and generating units, it is important to keep at a minimum the use of additional material and labor which may be utilized to better advantage in the various war industries for the successful prosecution of the war.

Staggering of Heavy Loads.—Periodic overloads on supply feeders may be reduced by a systematic staggering of the heavier loads according to a prearranged

time schedule. Some machine operations requiring heavy currents may be performed on different shifts in shops where two or three shift work is in effect.

Improving Drives.—The normal operating conditions of all motors should be checked and compared with their rated output. Much needed feeder capacity may be made available by rearranging motors so as to operate them near their maximum efficiency. In making these changes, it is necessary to bear in mind that of two motors of the same rated output, the motor with the higher rated speed has usually the higher efficiency. Also, the speed regulation of a driven machine is in most cases more efficient, if not more convenient, than the speed regulation of the driving motor.

Maintaining Rated Voltage.—When induction motor load constitutes the major part of a combined power and lighting load, more cable capacity may be made available by maintaining rated voltage at the load or even by raising the delivered voltage a few per cent above rated voltage. If lighting is on a separate system, the supply voltage to electric motors may be raised to 10 per cent above the rated voltage. Under these conditions, primary and secondary currents will be lower for any given load. While magnetizing current and core losses will be somewhat higher, these losses will be more than compensated for by the decrease in primary and secondary copper losses resulting in a slightly higher efficiency. The starting and pull-out torques will be increased about 20 per cent. Friction and windage losses will not be affected.

A terminal voltage of 10 per cent lower than rated voltage has a much greater effect on the full load current, torque and temperature rise of a. c. motors than it has on their speed. In d. c. motors, a 10 per cent voltage drop has little effect on the temperature rise but causes the full load current to be almost 12 per cent higher and thus puts an undue load on the supply feeder. A 1 per cent drop in incandescent lighting voltage causes a reduction of about 1.5 per cent in lighting load but a loss of almost 3 per cent in lumens illumination. Although the effect of voltage drop on fluorescent lighting is relatively less, this type of lighting may fail completely at an undervoltage exceeding 10 per cent.

Improving Lighting System.—The load on the feeders may also be reduced by using fluorescent lighting which has a higher lumen output per watt. Intelligent location of outlets and better cleaning of lighting fixtures may allow a more economical system of lighting.

Improving Power Factor.—In electric power applications where induction motors constitute the major part of the load, there is a possibility of improving the system power factor and thereby reducing the line current in the feeder for a given amount of energy consumed. Power factor may be improved to the most economical percentage through the use of synchronous or static condensers or synchronous motors operated at a suitable power factor partly for one of the larger drives and partly for the supply of leading current.

Transformers whose secondaries are not supplying any load should be kept disconnected from the line. Underloaded motors and transformers should be replaced by others of proper size operating nearer their maximum power factor. In applying motors to specific drives, higher speed motors which operate at higher power factor and efficiency should be given preference. This may be made possible by the use of higher ratios of speed transformation or by the use of gearmotors.

Increasing Size of Conductors.—It is sometimes possible to replace the feeders with heavier ones of standard insulation thickness. When this replacement is not possible, more copper cross-section can be pulled into the existing conduit by using new type thin insulation wires or cables. If other feeders are available which as a result of the relocation of major production units have been underloaded, the feasibility of a multiple or ring bus system should be investigated.

Redetermine Load Centers.—When the added copper cross-section made available by the use of small diameter cables fails to meet the increased demand, a survey should be made of the distribution system so as to redetermine load centers, their magnitude and probable growth. If the feeder in question is long and the load which has outgrown its distribution system is beyond a possible solution by any of the foregoing methods, the use of transformers supplied at a higher voltage should be given consideration. A distribution panel should be provided in a central location of each load center.

General Maintenance.—It is the maintainer's duty to make periodic insulation resistance tests of the wiring system to determine any wasteful leakages and probable deterioration of conductor and electrical equipment insulations. The equipment should also be periodically inspected to avoid arcing contacts, loose connections, local heating in windings, mechanical difficulties in drive shafts and equipment which unnecessarily raise the energy consumption.

R. G. Cazanjian

—And Don't Forget the Economics

There are several methods of correcting the condition mentioned in the question, but it is not possible to state any specific way which will be most economical in every case. The exact method which will prove to be the most economical can be determined only by a study of the relative costs of applying the several applicable methods discussed below. It will depend on the characteristics of the load and the cost of the material and labor required by the various ways which may be applied to obtain the desired result.

It may be possible to extend the useful life of the existing feeder by reducing the current being carried to a reasonable value, which the rubber insulation, in its present condition, or new wires of the same size and insulating material can carry without undue depreciation. This reduction of current may be obtained in several ways: (1) By transferring all or part of the load to a new line; (2) by transferring part of the load to other feeders in the vicinity which are not fully loaded; (3) by raising the voltage of the line to the upper limit of the insulation value of the conductors; (4) by power-factor improvement; (5) by use of heat-resistant insulation, and (6) by use of thin-wall insulation and larger copper.

The problem may be solved by working on another angle; that is, increasing the current-carrying capacity of the present conduit by scrapping the present feeder. It will probably be possible to install a new set of conductors with a current-carrying capacity sufficiently greater than the existing feeder, so that it will easily handle the present load and provide a reasonable margin for future additions. This may be done by (5) using the same size conductors but an insulation which will operate successfully at a higher temperature, or (6) by using larger conductors but thin-wall insulation so that the overall diameter is of such size that they will fit into the present conduit.

To determine the most economical way to do the job,

the cost of each method must be evaluated. Method 1 will require the construction of another underground or overhead line of such capacity that the load on the original line will be reduced to within reasonable current-carrying limits which will cause no further undue depreciation of the insulation. This scheme is feasible only if another route is available for running the relief line at reasonable cost and it is also possible to divide the load between both lines by splitting it into two blocks. It is never advisable to parallel two lines, whether they are of unequal or equal size, if they are run by different routes, as the shorter one will carry more than its normal portion of the current.

It is often possible to relieve loaded lines by redistribution of loads on all feeders in the vicinity. If this condition exists in the particular case under discussion, Method 2 can probably be applied with very little capital outlay. In this event, it is assumed, of course, that the total load consists of several separate branches or devices which can be reconnected to other feeders.

Method (3) may be applied where it is possible to install a step-up transformer at the point where the overloaded feeder connects to the main system, thereby raising the voltage and reducing the current of the entire feeder to some value which is within the safe operating voltage and current values of the depreciated insulation. At the load end of the line, it will be necessary to install a step-down transformer or reconnect the equipment which composes the load, if it is possible, for operation on the higher voltage. If this method is used with a fairly low voltage ratio between the original and the stepped-up lines, it probably will be more advantageous to use autotransformers which have a somewhat lower first cost and less operating losses.

A simple and economical way of reducing the current may be obtained by Method 4, power-factor improvement, which may be used if the line current is lagging to such an extent that its resistive component does not exceed the carrying capacity of the original conductors in their present condition. Under these circumstances, it is a relatively simple matter to install capacitors at the load to the extent necessary to reduce the lagging reactive component of the current, so that the line current falls to the desired value. For a further discussion of power-factor correction, see the Consulting Department, October issue of *Railway Electrical Engineer*.

The capacity of the line may be increased sufficiently by installing a new set of cables of the same conductor size, but with insulation suitable for operation at a higher temperature and, therefore, capable of carrying a greater current (Method 5). Since the original feeder has code grade rubber insulation (Type R), it may be replaced with heat-resistant rubber (Type RH), for example. Suppose that the original line operates at under 600 volts and consists of three No. 1 conductors in a 1½-in. conduit. The carrying capacity, according to the 1940 National Electrical Code, would be 91 amperes. By replacing with the same size cables, but with RH type insulation, capable of withstanding an operating temperature of 75 deg. C. instead of 50 deg. C., the permissible capacity is increased to 131 amp.

The application of Method 6 to the above-mentioned example will result in the use of a thin-wall type of insulation which will permit the use of a greater amount of copper in the existing conduit. Suppose the original feeder is removed and it is decided thin-wall synthetic insulation, type SN, which will withstand a maximum operating temperature of 60 deg. C. The largest size of wire with this insulation which the code permits to be installed in a 1½-in. pipe is three No. 000 cables. This feeder will then have an allowable current-carrying capacity of 166 amp. Hence, it may be noted that increases of 40 or 75 amp., 44 or 82.5 per cent, respectively, are available by replacing the original cables and still using the same conduit.

In summarizing, it might be noted that for short lines the cost of replacing the cables will generally work out to be most economical and can be done with a very small amount of labor. When the line is very long, a careful study of the other methods must be made, in addition, before the certainty of the cheapest way of doing the job can be established.

Stanley A. Kroll,
Electrical Engineer.

All Up in the Air

(Continued from page 55)

ton at the desk in the outside office to signal me when I'm wanted on the phone will be O. K. You can get that in right away, can't you?"

As the days went by, the job at the air field began to run more smoothly. Ray Duncan, a young fellow that had a twisted foot and thus not eligible for military service, was hired as a junior electrician to help Sparks. Two enlisted men that had had some experience were temporarily assigned to help also. Tools that had been ordered for the electricians began to come in—pliers, all sizes, shapes, and kinds, all of the best; screwdrivers, Stillson wrenches, testing instruments—Sparks had forgotten that such things were to be had at all. He got quite a kick out of just handling the tools, but what he liked most was the jeep junior temporarily assigned for the electricians' use until delivery could be obtained. He thrilled at the power and pickup of the little peep that went places in high where a goat would have to go in low.

One thing that surprised Sparks a lot was the number of men that had left the railroad to work at the air field. Some of them had given up a good many years seniority and he began to wonder about his own. He was rather expecting and hoping that the railroad company would allow him to stay for the duration.

Despite the red tape incidental to all government enterprises and annoyance that are part of any job, he liked it. Then, perhaps because he was working with and around men in the service, Sparks felt that he was doing a job that was more a part of the war effort than railroading, although he knew that wasn't actually true. Railroad operation, as the master mechanic had reminded him, is just as much a part of the war effort as building planes or even flying them.

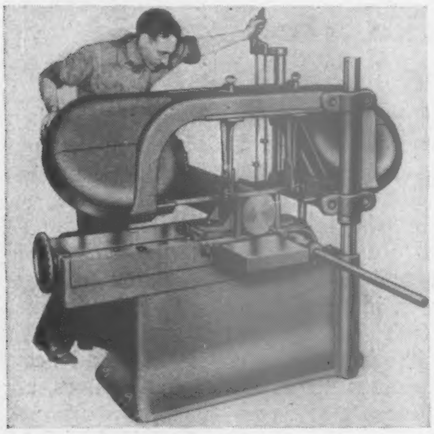
The day the new drill press and small lathe for the electric shop arrived at the air field, Sparks received a letter from the master mechanic stating that the request for his leave of absence to work as electrician at the air field had been refused and he must either report back to the railroad in forty-eight hours or forfeit his rights. His first reaction was to tell the railroad to go to Hades or some other seaport, but then on second thought he had many years seniority on the railroad and only thirty days at the air field, and railroads are essential too.

Carter was reasonable when Sparks reported. He allowed the electrician to work fifteen days more at the air field. Most of all Sparks hated to leave all those bright shiny new tools and the peep that didn't require a ration card for gas or tires.

NEW DEVICES

Large Metal-Cutting Band Saw

With a capacity for cutting 13-in. by 16-in. rectangular and 13-in. round stock, the new Model V-12 metal cutting band saw, recently developed by the Wells Manufacturing Corporation, Three Rivers, Mich., extends the advantages of continuous metal cutting to many larger jobs that previously could not be handled on small low-cost band saws. The V-12 incorporates the best features of Wells Models 5 and 8 machines and in addition offers a new hydraulic control feed and lift apparatus as well as several other developments.



Large Wells metal-cutting band saw

The most radical departure from previous designs is in appearance. To provide the necessary ruggedness for the increased capacity, the frame has been completely redesigned.

The V-12 is equipped with a ¾-hp. electric motor which drives the blade at a choice of three speeds, 53, 94 or 148 ft. per min. Taking advantage of this choice of speeds, it is said that, with this machine, it is possible to cut almost any metal in almost any shape.

In size, the V-12 is 52½ in. in over-all height and requires a floor space of 73 in. by 30 in. The top of the bed measures 24 in. from the floor. The total weight of the saw is 1,750 lb. Other details of the saw include a hand-operated quick-acting vise, belt and gear drive and ball-bearing support of moving parts.

Stainless Steel Substitute

A non-magnetic manganese alloy, which can be substituted for stainless steel, has been announced by the General Electric Company, Schenectady, N. Y. The new alloy will free nickel, chromium and tin for other war uses. All three metals are listed by the War Production Board as "inadequate for war and most essential uses" while manganese, the substitution of which makes the saving possible, is available in greater quantities.

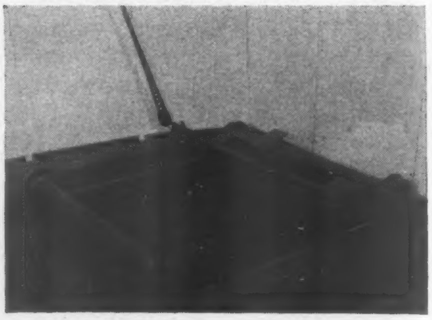
The new alloy replaces a formula which called for 18 per cent chromium, eight per cent nickel and the remainder iron. Either alloy requires a covering to permit soldering, and for the tin coating previously used, a lead coating has been substituted. Adequate supplies of lead are available.

Bars, rods and plates made of the new alloy are used in motor-generators for submarines, control equipment for planes and tanks, and in switchgear equipment and motors for war industry generally. Wire made of the alloy has sufficiently high strength to make it suitable for use as banding wire on the traction motors of electric locomotives.

Lifting Jack and Elevating Dolly

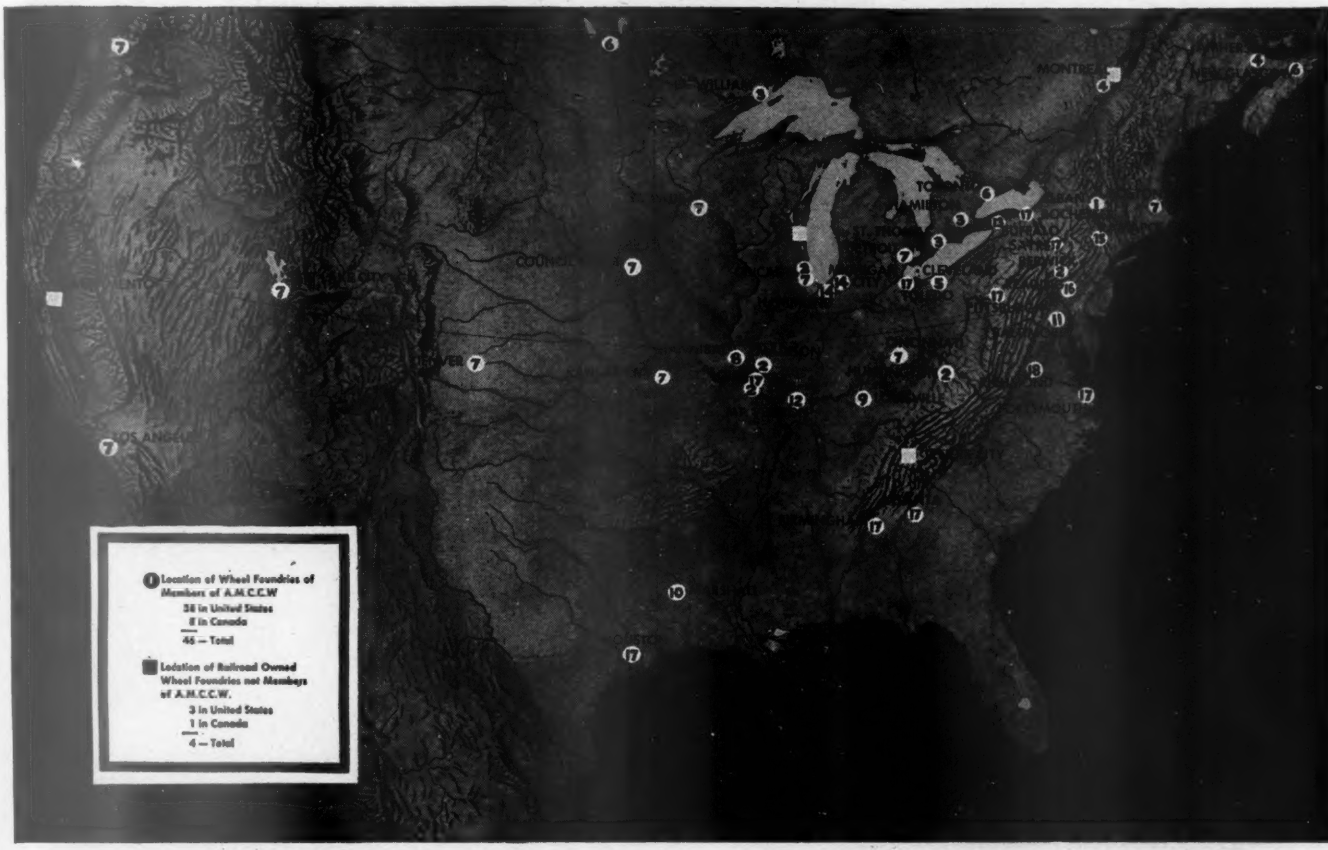
Two recently developed tools for use in maintenance of steam and Diesel locomotives have been announced by the Whiting Corporation, Harvey, Ill. The first is a portable high-lift electric jack which has a capacity of 140 tons. The jack is suitable for indoor or outdoor use. It is so designed that narrow- and standard-gauge steam locomotives, Diesel-electric locomotives or passenger cars can be quickly raised and lowered. Slotted feet allow the beams on the jacks to be lowered below track level and the beams themselves can be removed to permit Diesel locomotives to be raised on the pads of the jack. Limit switches and other safety devices are built-in features of the jack.

The second device is a four-wheeled dolly, equipped with an elevating mechanism, for removing mounted wheels and the motor assembly from Diesel-electric locomotives. The elevating arrangement is built with an adjustable tilting plate operated by a ratchet wrench from either side of the dolly. This plate is used to tilt the nose of the motor during wheeling or unwheeling operations.



Elevating dolly for use when removing or replacing wheels in Diesel-electric locomotive trucks

Electrically operated lift jack for use under standard and narrow-gauge steam locomotives, Diesel-electric locomotives and passenger cars



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Glass Reflectors Save Aluminum

Using mirror glass reflectors with silver backing and cast iron hoods, the Westinghouse Lighting Division, Cleveland, Ohio, is producing improved yard lights and at the same time conserving war-needed aluminum. The new lights produce about 10 per cent more illumination.

There are two reasons for this increased efficiency. The mirror glass reflects more

One of the lighting units undergoing assembly

light than aluminum, and it extends below a globe clamping ring that formerly blocked off part of the reflected light.

Although the conversion of aluminum to war uses made it necessary for Westinghouse to substitute silvered glass reflectors, the new lights were so designed that the reflectors are interchangeable with the aluminum units. This makes it possible for war industries to renew old yard lights without buying complete units.

Turret Lathe With Automatic Indexing

Previously furnished with a manually controlled, six-station turret, the Oster No. 601 lathe is now equipped with automatic indexing. The machine, having a capacity of 1½ in. (round) for cutting-off, boring, tapping, reaming, facing, threading, and for many other operations, is simplified in design and construction to meet requirements for low cost and easy operation. The simplicity of the machine recommends it for use in rapid and efficient training of new operators. Where three or fewer operations in sequence are required, the machine can be furnished with a plain saddle instead of the six-station turret.

Purchasers can specify a worm or direct drive to the spindle, a two-speed motor, reverse, or electric brake control. The motor connects by means of multiple V-belts and speed changes. On the worm-drive design the speed changes are obtained by the application of quick-change sheaves for 140

This six station turret lathe is equipped for automatic indexing

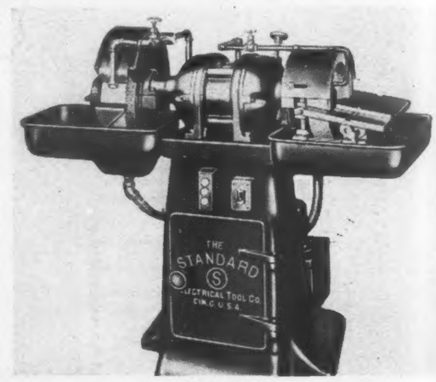
to 1,000 r.p.m. with a motor operating at 1,800-3,600 r.p.m., 70 to 500 r.p.m. with a 900-1,800 r.p.m. motor. On the direct-drive design speed changes range from 900 to 3,000 r.p.m. with an 1,800-3,600 r.p.m. motor and 450 to 1,500 r.p.m. with a 900-1,800 r.p.m. motor. The spindle is mounted on ball bearings. A belt-connected coolant pump is assembled in the machine base. The machine occupies 33 in. by 70 in. of floor space, without its far-feed extension, which requires 94 in. beyond the pan. The net weight of the machine is approximately 1,700 lb. These lathes are built by the Oster Manufacturing Company, Cleveland, Ohio.

Tube Cleaners for Locomotive Boilers

A complete series of fast operating cleaners for syphons, circulating tubes, arch tubes, branch pipes and automatic blowdown pipes are manufactured for locomotive boiler work by the Airetool Manufacturing Company, Springfield, Ohio. The various tools are operated by powerful motors and all wearing parts are made of alloy steels to give long life and lowered maintenance costs. The cleaners are equipped with newly designed non-tracking cutters to insure safety to the tube walls. Various types of heads can be obtained to widen the useful range of the tools.

Adjustable Table for Carbide Tool Grinder

A carbide tool grinder which has a table that is not only adjustable to angles with suitable graduations for the tool which is to be ground but which can also be adjusted to compensate for wheel wear is being produced by the Standard Electrical Tool Co., 1899 W. Eighth st., Cincinnati. It is equipped with a 3-hp., 1150-r.p.m. motor for use with a straight grinding wheel 18 in. in diameter by 2½ in. face for rough-



Wheel-wear compensation is a feature of this carbide tool grinder

ing operations. Suitable flanges accommodate this size wheel with a 10-in. hole.

On the opposite end of the spindle is a steel plate which takes cylindrical wheels 14 in. in diameter for face or finish grinding. This has a wet grinding attachment and a separate toggle switch for controlling the motor-driven pump. The machine has a reversible motor. In addition to the size described, similar machines are available in 1 hp. 10-in. and 2 hp. 12-in. sizes.

Forced-Convection Heaters

Forced-convection electric heaters are now being made by the General Electric Com-

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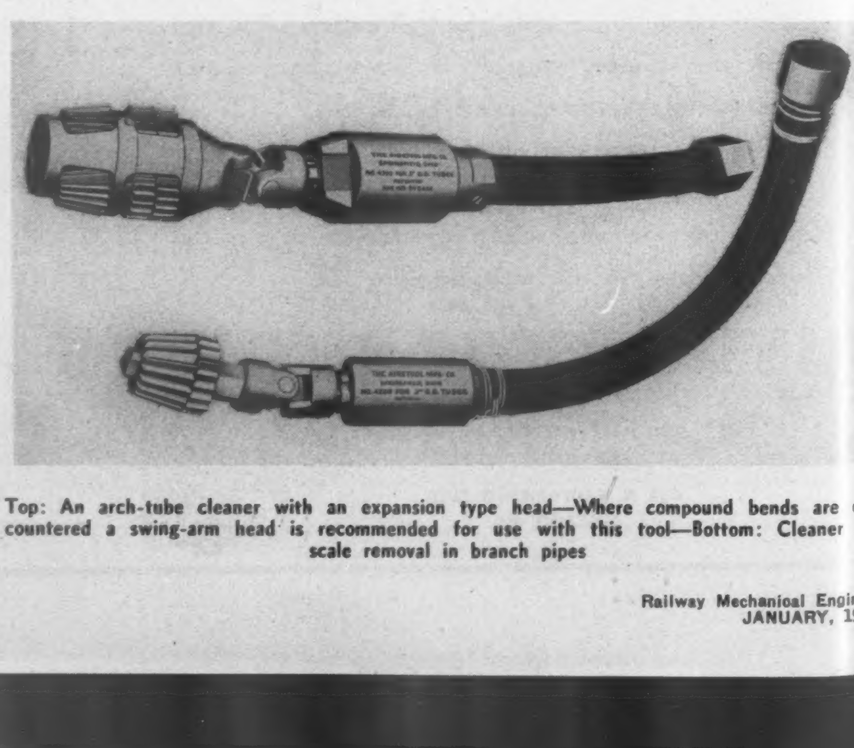


Top: An arch-tube cleaner with an expansion type head—Where compound bends are encountered a swing-arm head is recommended for use with this tool—Bottom: Cleaner for scale removal in branch pipes

pany, Schenectady, N. Y., for the cabs of electric locomotives, watchman's towers, substations, warehouses crane cabs and similar out-of-the-way places.

Controlled automatically and rated from 2 to 15 kw., the heaters are available in the suspension type for wall and ceiling mounting. The portable type, which while intended primarily for floor mounting, is readily adaptable for either wall or ceiling use. In some applications they effect economies by eliminating the installation and maintenance of steam piping to remote points, as well as the heat losses from such pipe lines.

A convection heater installed in the cab of an industrial electric locomotive

High-Speed Vertical Turret Mill

A high-speed vertical turret mill designed for boring, drilling and turning non-ferrous castings and forgings in high-speed production work has been developed by the Rogers Machine Works, Inc., 125 Arthur street, Buffalo, N. Y. Universal adaptability of these boring mills is increased by the use of a swivel side head that is adjustable at any angle each side of vertical up to 35 deg. to facilitate quicker tool setting on irregularly shaped pieces. A built-in graduated dial saves time in making set-ups for original and second runs.

Turret mill intended for use on non-ferrous castings and forgings—The main and side heads are shown

The horizontal chuck permits the work to slide easily and quickly into exact position in a minimum amount of time which reduces mill down time.

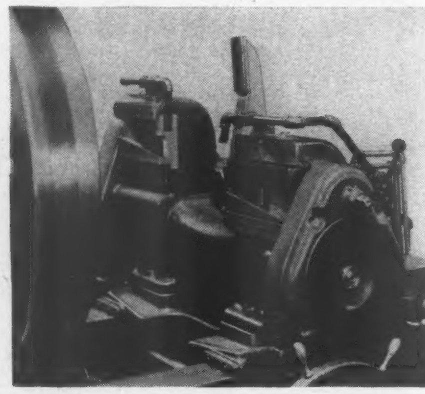
The main drive sheave of this high-speed model runs at 760 m. p. h. which is double the 380 r. p. m. of the standard Rogers vertical turret mill but both models have the same working capacities of 36 in.

Cut-Off Unit for Pipe Machines

The Landis Machine Company, Waynesboro, Pa., has recently developed a hydraulically controlled cutting-off unit. This device replaces the standard carriage, crossrail, and die head of the Landis mill-type pipe-threading machines where these machines are to be used only for the cutting-off operation and when maximum operating efficiency is desired.

The hydraulically-controlled cutting-off device uses two high-speed-steel cutting-off tools mounted in heavy slides. These tool slides function through a hydraulic cycle which provides rapid traverse of the tools to the work and rapid return of the tools after the cutting-off operation is completed. A single lever controls both the forward and return movements of the tool slide.

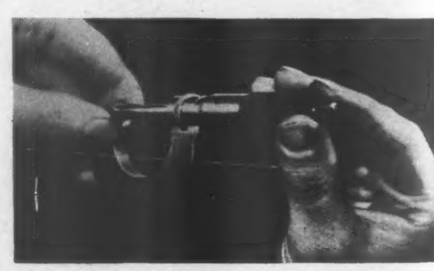
Complete operator control of the hydraulic cycle provides variable feed rates for the tools and adjustment of the length of travel of these tools for different thicknesses of tubing. The adjustment for rate of feed is made through a single control valve so that the rate of feed, for both the front and rear cutting-off tools will be the same. The tool slides are adjustable, within certain limits, for various diameters of tubing.



Hydraulically controlled cut-off head which replaces the standard carriage, crossrail and die head on Landis mill-type pipe-threading machines to be used exclusively in cutting off tubing

Silk Substitute Insulating Materials

Varnished rayon, varnished cotton cloth and varnished nylon have been developed by the Irvington Varnish & Insulator Company, Irvington, N. J., for electrical insulation formerly provided by varnished silk. All these materials possess good dielectric strength with tensile and tear strengths equal to or better than varnished silk and can be punched into special shapes. They are available in thicknesses from .003 in. to .008 in. in straight-cut rolls or bias cut strips in 51-in. lengths. Each base material is coated with Irvington special insulating varnish.



Dielectric strength of the three alternate materials is 1200 volts per thousandth inch thickness

Varnished rayon is the most suitable alternate for varnished silk, comparing favorably with it in strength and flexibility. It is used for wrapping leads, small magnetos and coils. Varnished cotton cloth has greater tensile strength than varnished silk. Its pliability permits application on odd shapes. Varnished nylon has qualities of flexibility and high tensile strength. At this time nylon is only available by government allocation.

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High Spots in
Railway Affairs . . .

Two Million Soldiers Moved Every Month

According to Col. E. C. R. Lasher, deputy chief of the Traffic Control Division, Army Transport Corps, about two million soldiers are now being moved each month by the railroads in this country. This requires about 15 per cent of the day coaches and one-half of the sleeping cars. These requirements, coming at a time when civilian traffic is at a maximum, because of the nationwide gasoline rationing, naturally stress the railroad facilities to the limit. Moreover, as Colonel Lasher pointed out, "when a soldier moves, all his equipment has to go with him, so that he can dress himself, eat, drill, and if necessary, fight at a moment's notice."

Conventions in Wartime

Railroad passenger traffic has increased more than 50 per cent above last year's level. Troop movements are requiring more and more of the railroads' facilities. Director Eastman of the ODT emphasizes the fact that the railroads will have "extremely limited facilities in 1943 for passengers not in the armed services or not on business of an essential or emergency character." It is, of course, impossible for ODT to pass upon each of the many thousands of meetings and conventions that are normally held each year in the United States. It is suggested, therefore, that the officers and members of these individual organizations should ask themselves if the gathering will help shorten the war, and should abandon plans for meetings unless the question clearly merits an affirmative answer.

Air Line Competition

Many fantastic claims are being made about the extent to which the airplanes will take business away from the railroads after the war. While there is no question that the airplane will offer stiff competition to the railroads for passenger, mail and express package traffic, the handling of freight is quite a different matter. W. A. Patterson, president of the United Air Lines, in speaking before the National Industrial Conference Board, made a very thorough analysis of the costs of train and airplane operation. His conclusion was that, "When statements are made that our older forms of transportation—the railroads and steamship lines—are doomed, such statements cannot be supported by facts." Mr. Patterson pointed out that the future of the airplane in commerce is indeed great, but it appears that this future can be realized without serious inroads upon the steamship lines or the railroads. "The volume of domestic air cargo could increase one hundred-fold and yet capture only one-tenth of one per cent of the freight ton-miles now carried by the American railroads. But apart from that, the airplane should be expected to stimulate the generation of the type of traffic that is the rightful field for surface carriers."

Railroad Safety Awards

The late Arthur Williams, of the New York Edison Company, was deeply interested in accident prevention and for many years headed up the American Museum of Safety, which was organized even before the National Safety Council. It was through this organization that the Harriman Safety Awards, which have been so effective in stimulating safety activities on American railroads, were made. Mr. Williams made provision in his will for the establishment of the Arthur Williams Memorial Medal. The initial awards were recently made for distinctive achievement in safe transportation—one in the railroad industry, one in the marine field, and another for the airways. The rail transportation safety medals were awarded in duplicate to W. Averell Harriman and E. Roland Harriman "for continuing the inspiring leadership of two generations in safe transportation." E. H. Harriman, during his lifetime, went to unusual lengths to insure safe operation of the railroads under his direction. This is reflected in one way by the remarkable safety records that have been made over the years on the Union Pacific. It was after Mr. Harriman's death that his widow, the late Mary W. Harriman, established the Harriman safety awards. Her sons not only continued these medals, but have in many ways taken an active interest in the promotion of accident prevention movements. The presentation was made by Joseph B. Eastman, director of the Office of Defense Transportation.

"Make-Work" Practices

The demand of the five railway operating unions for a 30 per cent increase in wages is having some unexpected repercussions. A typical example is the editorial comment in the New York Times. Among the instances cited in its editorial on "Make-Work on Railroads," it included one case in which "a local freight crew dropped three cars and picked up three other cars on an oil company siding, doing work which required 15 minutes. There was no switch engine crew on duty at the time at this point. For this work the Board (National Railroad Adjustment Board) ordered not merely that the local freight crew should receive extra compensation, but that an extra yard foreman and an extra switchman, who were not on duty and performed no service whatever, should be awarded a day's pay for not having been used to do this work." The Times went on to say, "These are a few among many such decisions by the Board. They require the employment of additional men to perform work which these men are not needed to perform, and the employment and payment of men for whom there is no work available. It is clear that such decisions have compelled the railroads in many cases to adopt costly, wasteful and inefficient methods. In a total war, when skilled manpower falls far short of our needs, and when maximum production is a question of national survival, such make-work practices become inexcusable."

Traffic Solicitors And War Conditions

Interstate Commerce Commissioner J. Monroe Johnson, in correspondence with J. J. Pelley, president of the Association of American Railroads, criticized the practice of tracing shipments for individual shippers under war conditions. He even went so far as to suggest that railway traffic departments should be abolished for the duration. President Pelley pointed out, however, that the freight traffic solicitor is the contact man between the railroads and the shippers and can exert a most helpful influence in inducing co-operation to secure maximum efficiency from the available facilities. The traffic department personnel has also been reduced because of losing men to the armed services. There is plenty of constructive work to be done by those remaining in service, entirely aside from the actual solicitation of traffic.

Oil to East Coast

The fuel oil and gasoline situation on the East Coast is distressing. The amount of petroleum products being handled in tank cars by the railroads is well below 800,000 barrels a day; it was only 736,099 in the week ended December 12. The peak movement of 856,710 barrels daily was attained in the week ended September 19. Cold weather has had some effect in slowing up the movement and at the same time has increased the consumption in the eastern states. The ODT, working with the AAR, is using every means to increase this movement. Petroleum Administrator Ickes flew off the handle on December 10, and said that he had told President Pelley the railroads had to do "a damned sight better job than they have been doing lately." Obviously this was a very unfair statement; the railroads have been doing a magnificent job in moving oil and are entitled to commendation, rather than chastisement.

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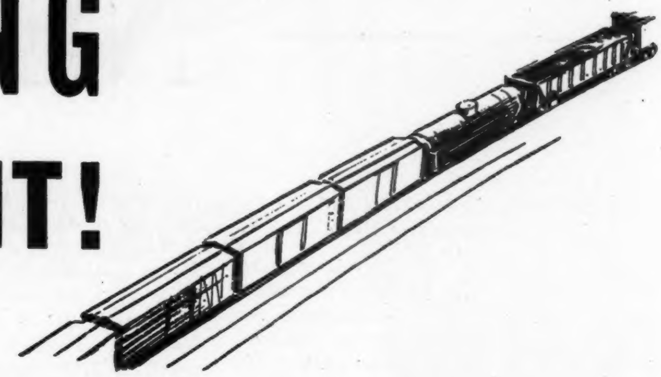
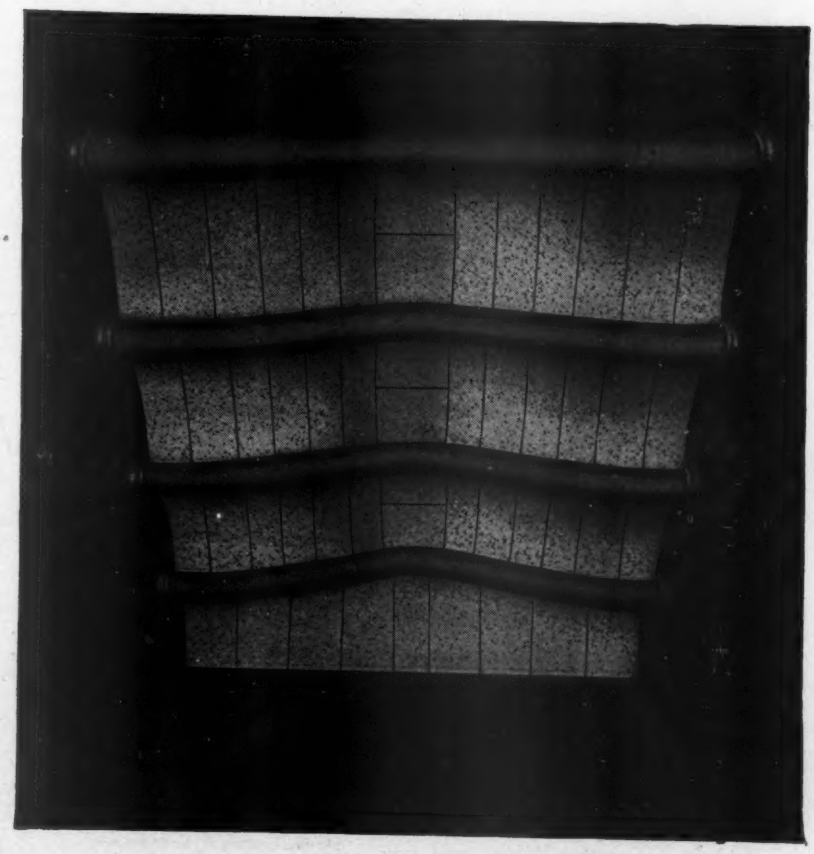
FUEL SAVING
AN ARCH HABIT!



Over 32 years ago railroad men satisfied themselves as to the fuel saving of the locomotive Arch.

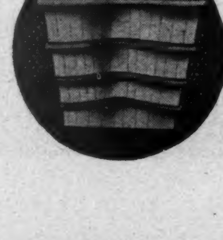
Since then the increase in locomotive power, higher rates of combustion and the widespread use of stokers has increased the fuel savings attributable to the Arch.

Today, when conservation of fuel is so vitally important to our war effort, don't handicap the effectiveness of the Arch by skimping on Arch brick. When your locomotives leave the roundhouse, be sure they are equipped with a *complete* Arch.



HARBISON-WALKER REFRACTORIES CO.

Refractory Specialists



AMERICAN ARCH CO.
INCORPORATED
60 EAST 42nd STREET, NEW YORK, N. Y.

Locomotive Combustion Specialists

NEWS

Alldredge Elected I.C.C. Chairman for 1943

REVERTING to the plan of rotating that office annually on the basis of seniority, the Interstate Commerce Commission has elected Commissioner J. Haden Alldredge as its chairman for the year 1943. He will succeed Commissioner Clyde B. Aitchison who served throughout 1942, first as acting chairman, and as chairman since the expiration on July 1 of the three-year term of Commissioner Joseph B. Eastman, who is on leave as director of the Office of Defense Transportation.

ODT Bulletin Lists Training Aids

THE Office of Defense Transportation's Division of Transport Personnel has prepared a bulletin describing the services of six government agencies which are prepared to assist the transportation industry in meeting the manpower shortage. Listed in the bulletin are facilities of the Civil Aeronautics Administration, the War Shipping Administration, and four agencies supervised by the War Manpower Commission. The latter are the Apprentice Training Service, the Training Within Industry Division, and two activities of the Office of Education, Engineering, Science and Management War Training and Vocational Training for War Production Workers. The bulletin is available from the ODT Division of Transport Personnel, Washington, D. C.

Equipment Purchasing and Modernization Programs

Central of Georgia.—The Central of Georgia is endeavoring to purchase eight steam freight locomotives of 4-8-4 wheel arrangement.

Missouri Pacific.—The Missouri Pacific has been authorized by the District Court to spend $4,613,380 for new equipment including 15 steam locomotives to cost $3,123,000.

Southern Pacific.—The Southern Pacific has applied to the Interstate Commerce Commission for authority to issue and sell $3,950,000 of equipment trust certificates, Series U, the proceeds to be used to finance in part the purchase of 22 oil-burning steam locomotives at a total cost of $5,350,394—18 of the 4-8-8-2 type, Class AC-11, from the Baldwin Locomotive Works, and four of the 4-8-4 type, Class GS-6, from the Lima Locomotive Works. The certificates will mature in equal installments of $395,000 each on January 1 of each year from 1944 to 1953, inclusive, the maturities to and including January 1, 1948, bearing interest at two per cent, and the remaining ones at 2½ per cent.

Union Pacific.—Division 4 of the Interstate Commerce Commission has authorized the Union Pacific to include in equipment covered by an issue of $13,250,000 of its series G equipment trust certificates 1,000 50-ton gondola cars and 3 locomotives in place of 1,251 box-cars which the War Production Board will not permit it to construct. The box cars were part of an order for 2,000 being built in U. P. shops. The substitute 50-ton composite gondolas will be built by the Pullman-Standard Car Manufacturing Company, and three high-speed freight locomotives of the 4-6-6-4 type by the American Locomotive Company. In addition to the 2,000 box cars, the original program called for 20 locomotives, 70 passenger-train cars, and 100 cabooses.

"Surplus" Equipment Inventory Order Modified by WPB

MOVING to facilitate redistribution, for the current equipment program, of inventories in the hands of car builders, the War Production Board on November 24 issued a supplemental order, amending Limitation Order L-97-A-1 to broaden the scope of its inventory controls. The amendment extends to the inventories of passenger-car builders restrictions which previously applied only to those of freight-car builders; and makes the "excess inventories" of both such builders available to locomotive builders.

The "excess inventories" involved are the steel and other materials accumulated by builders in 1941 and early 1942 for the then-projected programs which were curtailed by WPB. Heretofore, such inventories of the freight-car builders could be sold only to other freight-car builders. Commenting on the broadening amendment, the WPB announcement said that "the emphasis at present is on the side of locomotive construction," adding that the supplementary order "is expected to accomplish a continuous balancing of inventories by permitting similar sales and exchanges in all departments of the business, including passenger and freight car shops, locomotive works, and parts manufacture."

Previously the announcement had pointed out that no passenger-car production was authorized in the recently determined 1943 program. Thus the desire to redistribute inventories of materials in the hands of passenger-car builders.

Rules for Replacing Motors

IN AN effort to put every usable motor in the country to work producing war materials, the WPB is appealing to manufacturers who have idle motors to make them available for sale and to all manufacturers to use their motors to best advantage and for as long as possible. The recently issued General Conservation Order L-221 is designed to encourage maximum use of existing motors and to conserve materials in future production.

Under the order, all purchasers desiring new motors must certify to the motor

(Continued on next left-hand page)

Orders and Inquiries for New Equipment Placed Since the Closing of the October, 1942, Issue

LOCOMOTIVE ORDERS

Road	No. of Locos.	Type of Loco.	Builder
Ann Arbor	2[1]	660-hp. Diesel-elec.	American Loco. Co.
Atchison, Topeka & Santa Fe	20[1]	4-8-4	Baldwin Loco. Wks.
Chicago, Milwaukee, St. Paul & Pacific	2	1,000-hp. Diesel-elec.	American Loco. Co.
Kansas City Southern	4	1,000-hp. Diesel-elec.	American Loco. Co.
Lehigh Valley	5[1]	1,000-hp. Diesel-elec.	American Loco. Co.
Nashville, Chattanooga & St. Louis	10[2]	4-8-4	American Loco. Co.
	5[2]	1,000-hp. Diesel-elec.	
Nevada Consolidated Copper Corp.	1[3]	1,000-hp. Diesel-elec.	Baldwin Loco. Wks.
New York, Susquehanna & Western	2[1]	1,000-hp. Diesel-elec.	American Loco. Co.
Northeast Oklahoma	1[3]	500-hp. Diesel-elec.	General Electric Co.
Richmond, Fredericksburg & Potomac	2[2]	1,000-hp. Diesel-elec.	American Loco. Co.
Wabash	2[1]	1,000-hp. Diesel-elec.	American Loco. Co.
Western Pacific	8[1]	1,000-hp. Diesel-elec.	American Loco. Co.

FREIGHT-CAR ORDERS

Road	No. of Cars	Type of Car	Builder
Ann Arbor	50[1]	50-ton hopper	Mather Stock Car Co.
Akron, Canton & Youngstown	50[2]	40-ton box	Wabash R. R. shop
Missouri-Kansas-Texas	17[1]	Caboose	Company shops
Monongahela Connecting	65[4]	120-ton gondola	Company shops
	20[3]	100-ton hopper	
Norfolk & Western	100[1]	70-ton gondola	Pressed Steel Car Co.
	25[1]	70-ton flat	Greenville Steel Car Co.
Union Pacific	1,000[3]	50-ton gondola	Pull.-Std. Car Mfg. Co.

FREIGHT-CAR INQUIRIES

Road	No. of Cars	Type of Car
Chicago, Rock Island & Pacific	400	70-ton gondola
Delaware, Lackawanna & Western	100	70-ton hopper
Denver & Rio Grande Western	200	70-ton flat
Northern Pacific	250	50-ton gondola
	300	50-ton flat

[1] Subject to WPB approval.
[2] Authorized by WPB.
[3] Authorized by WPB. For delivery January, 1943.
[4] Authorized by WPB. For delivery May, 1943.

manufacturer from whom they are ordering that they have no idle motor in their possession which can be adapted; that they have attempted to obtain a used motor from at least three dealers; that the motor is not being purchased for replacement purposes; and that it is required for immediate use.

The purchase of replacement motors requires specific approval by the War Production Board, granted only when repairing is impossible and used equipment unobtainable.

The order also contains a number of conservation and simplification provisions. It requires purchasers of motors to show that the horsepower of the motor for which they are applying is no greater than that required to do the job. It prohibits the delivery or acceptance of motors, unless they comply with standard manufacturing specifications and are of the simplest practicable mechanical and electrical design, with the smallest use of critical materials. The order also greatly restricts the use of special type motors, requiring additional manpower and materials to manufacture.

New York "El" Cars Now Carry War Workers in Illinois

FIFTY-FIVE former New York elevated cars are being reconditioned and placed in service on the Illinois Terminal to carry war workers from Springfield, Ill., to the Sangamon and Oak Ordnance plants near Illiopolis. The cars, formerly operated on the Sixth Avenue elevated line, were purchased by the government, which is paying the Illinois Terminal a flat sum for the service of an electric locomotive and a train crew. The cars were conditioned in the shops of the American Car and Foundry Company in St. Charles, Mo., while electrical work and final tuning up was done in Terminal Company's shops in Decatur.

The first cars, painted tangerine, were placed in service as the Victory Special on November 30, and were hauled by an electric locomotive that had been painted red, white and blue. Each car has three rows of seats, one one each side of the car and extending the full length of it and parallel with the sides, and a third, wide enough for but one passenger, in the middle. The capacity of each car is 80 persons. The fare charged by the government is $1.50 each week per person for the 25 miles.

Mechanical Division, A. A. R.

CARS DELAYED AWAITING REPAIR MATERIALS.—A recent A. A. R. Mechanical division circular letter points out that excessive delays are being experienced in making repairs to freight and passenger cars on foreign roads, where it becomes necessary to order repair materials from the owners and requests are transmitted by mail. This is true particularly where shops of the car owner of the repairing line are separated by a considerable distance.

Due to the urgent demand for passenger, tank and open-top cars, the circular instructs that when it becomes necessary to request material for repairs to such foreign cars from the car owner, such orders should be transmitted by telegraph, telephone, or air mail, and the material forwarded the same day if possible. Furthermore, any material weighing less than 250 lb. gross weight must be shipped by express, as specified in Rule 122.

The same method of handling requests for material should be followed between the repair point where a car is held and the office of the repairing line which transmits such requests to the car owner. The letter emphasizes the importance of this matter under present conditions and urges that it be brought to the attention of supervisors and all others concerned, in order to avoid all possible delay in returning cars to service.

ODT Union-Management Group Proposes Railroad Labor Transfer

A RECENT session of the railroad union-management conference, meeting with Office of Defense Transportation representatives in Washington, considered problems arising out of the railroad man-power shortage—threatened or already developed in certain localities—and selected a subcommittee to plan detailed procedure for the temporary shifting of railroad employees from places where the labor supply is adequate to spots troubled by shortages.

The subcommittee will make complete plans for arranging for employee leaves of absence for such purposes, for the maintenance of seniority rights by transferred men, for notice to be given men recalled to their original jobs, and for other measures intended to make the available labor supply go as far as possible.

Employees likely to be affected include engineers, firemen, trainmen, shop mechanics and skilled track workers.

Rock Island Shopmen Start Stay-on-Job Campaign

IN line with a nation-wide movement to avoid delays in vital war transportation, employees of the Chicago, Rock Island & Pacific shops are launching a program to "Stay on the Job." Every effort is being made to eliminate absenteeism which interrupts work schedules and holds up vitally needed equipment.

The unprecedented strain on locomotives and all types of equipment because of the demands of war transportation requires the services of every shopman for a maximum work week, it is pointed out. Periodic laying off by employees, even of one man for a single day, frequently cripples the output of a shop. Yet it is this type of irregularity, this laying off for brief periods, that is the most difficult to control, according to shop foremen and supervisors.

The "Stay on the Job" campaign is being augmented by a series of posters designed to emphasize the importance of regularity among workers on the home front. The first of the series pictures a railway shop worker and a machine-gunner with the caption, "They're on the Job, Let Us Stay on the Job."

ODT to Become "Claimant" Under Materials Plan

THE Office of Defense Transportation is to be made a "claimant agency" under the War Production Board's new Controlled Materials Plan which is being launched on a gradual basis to become fully effective next July 1, it was learned this week. Thus will the transportation industry come out from under the wing of the WPB Office of Civilian Supply to assume a place for itself on the Requirements Committee which doles out available materials.

Although no official announcement of the change had been made, it is understood

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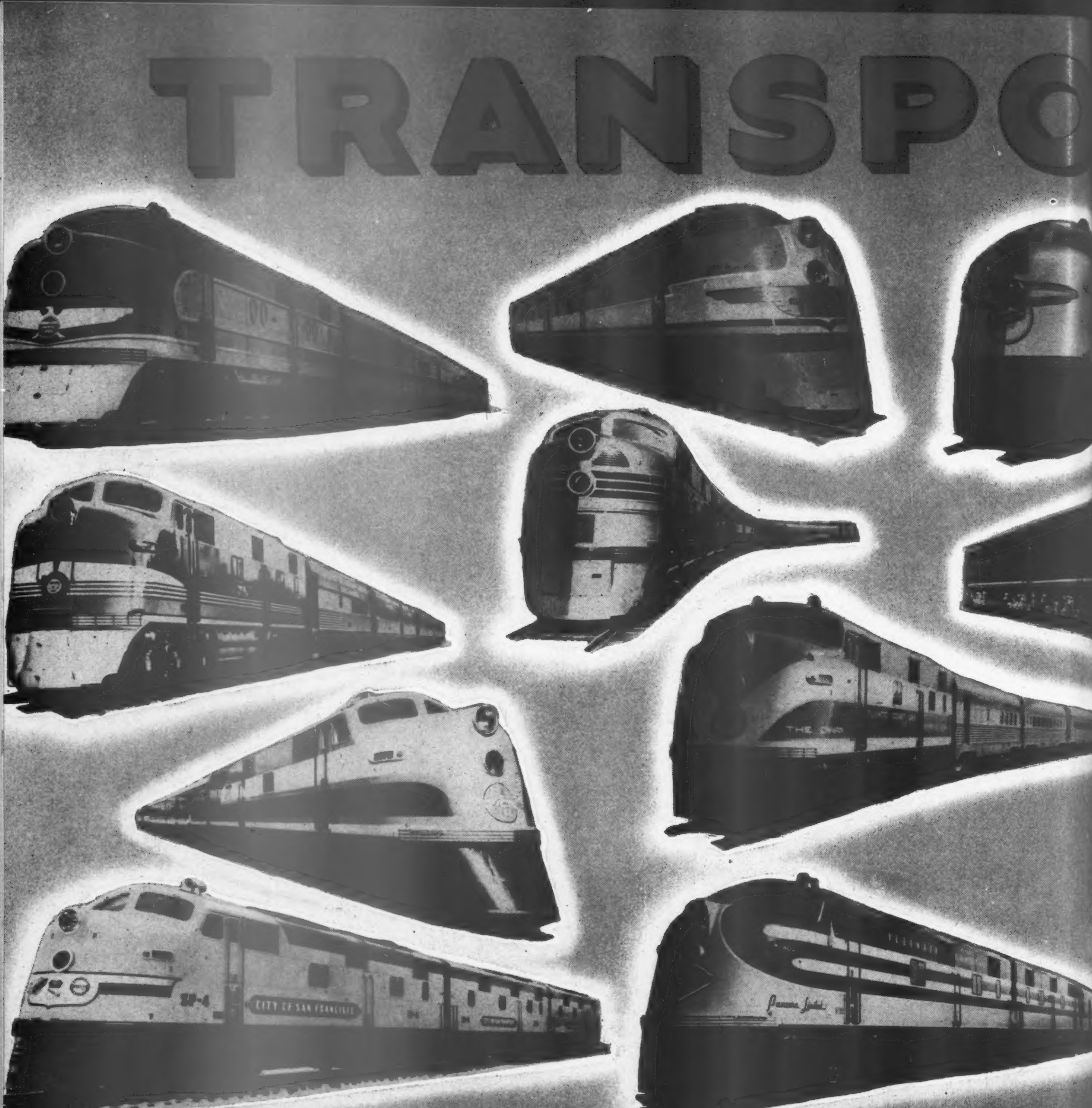
Eleven "El" cars and a red, white and blue locomotive make up the "Victory Special"



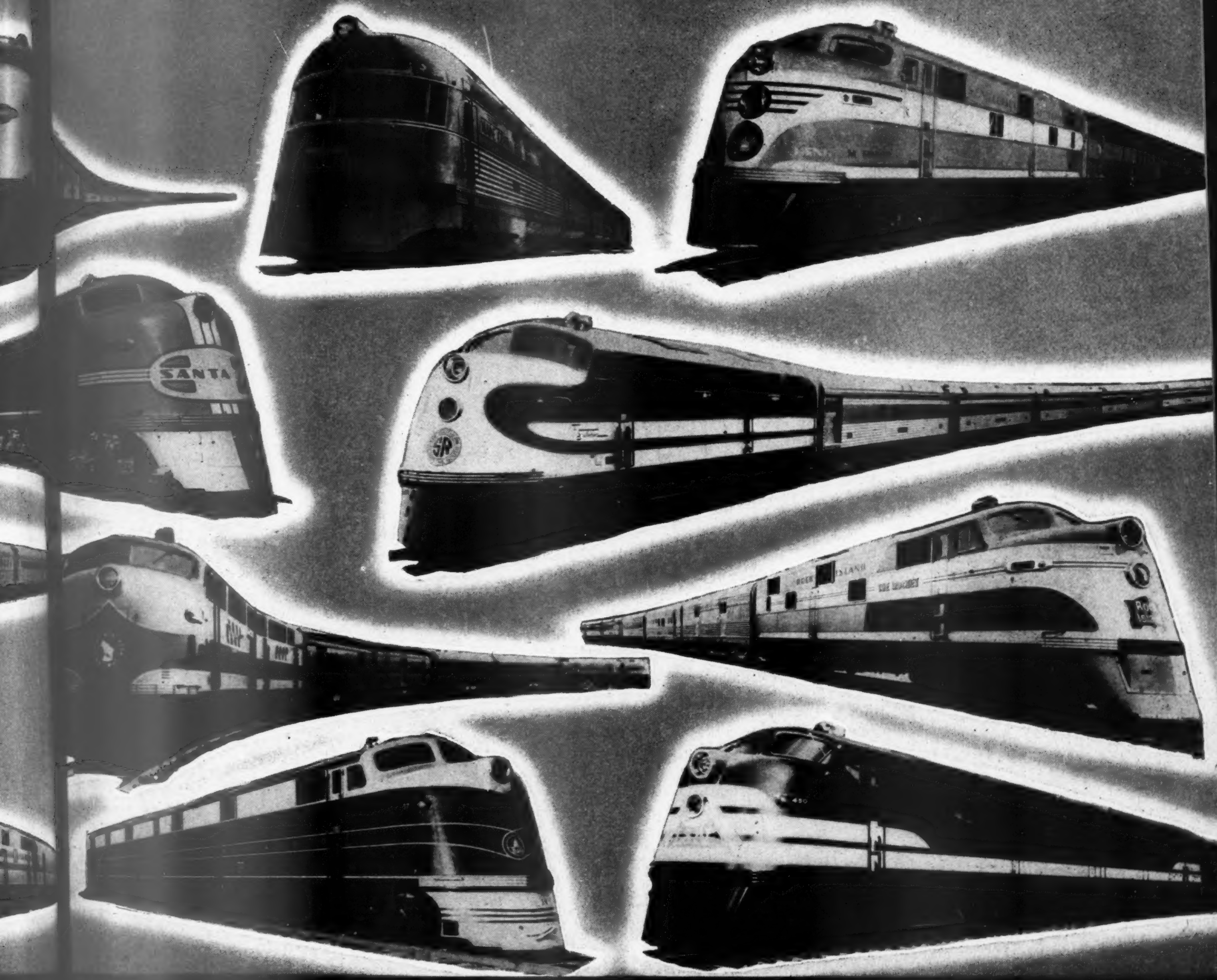
IN WAR

THE railroads of America, faced with the greatest transportation problem in history, are doing a phenomenal job. Transportation enters every stage of production from the time raw materials leave the ground until the finished products reach their final destination. Without transportation, guns, tanks and planes would be useless, because they can't fight in our factories • • • We have reached the point where the volume of both passenger and freight traffic exceeds all previous records, with the result that the railroads have been called upon to use every available unit of motive power to the very maximum of its capabilities • • • Time is everything. Every minute — every hour — every day counts. Fighting men cannot wait. Delay in getting equipment and supplies to our fighting forces may mean the difference between victory and defeat. General Motors Diesel Road Locomotives on 27 railroads are doing their part in meeting this challenge. Transportation is vital to VICTORY and—

VICTORY IS OUR BUSINESS

GENERAL MOTORS
LOCOMOTIVES

RTATION



IN PEACE

WHAT transportation problems peace will bring to the railroads, no one knows. But one thing is certain — the super-efficiency demonstrated during the war assures their ability to meet the new forms of competition and other conditions which they are bound to face after the war. Because of America's proven superiority in the building of planes and ships, it is reasonable to expect a public demand for more extensive improvements in rail equipment and service. The railroads are not going to relinquish their present leadership in passenger and freight transportation. They will carefully analyze the entire picture and plan accordingly. General Motors Diesel Road Locomotives will continue to make possible greater hauling capacity — faster schedules with maximum comfort and safety — high availability — less wear and tear on rail and bridge structures — lower operating costs — increased revenues.

WHO SERVES THE RAILROADS—SERVES AMERICA

GENERAL MOTORS LOCOMOTIVES

that ODT is one of several additional agencies to be given "claimant agency" status, the others including the Petroleum Administration for War, and the Office of Rubber Director Jeffers. As noted in the December issue, page 546, where the Controlled Materials Plan was outlined, the original "claimant agencies" were the Army, Navy, Maritime Commission, the Aircraft Scheduling Unit, Lend-Lease, Board of Economic Warfare, and the Office of Civilian Supply.

Civilian Supply's representative on the Requirements Committee has been Joseph L. Weiner through whom ODT presentations requesting material allocations for the transportation industry have heretofore been made. Mr. Weiner has been promoted from the position of deputy director to director of the Office of Civilian Supply, succeeding Leon Henderson.

Supply Trade Notes

THE INDEPENDENT PNEUMATIC TOOL COMPANY has removed its Boston, Mass., office to 78 Brookline avenue.

◆

THE PRIME MANUFACTURING COMPANY, Milwaukee, Wis., has acquired the products of the Graham-White Sander Corporation, Roanoke, Va.

◆

D. G. MITCHELL has been appointed vice-president in charge of sales of Sylvania Electric Products, Inc. This is a new office, established to plan and direct the distribution and merchandising of all Sylvania products.

◆

UNITED STATES STEEL SUPPLY COMPANY.—The name of the Scully Steel Products Company, Chicago, subsidiary of the United States Steel Corporation, has been changed to United States Steel Supply Company.

◆

HUNT-SPILLER MANUFACTURING CORPORATION.—*Preston W. Lampton* has been appointed representative of the Hunt-Spiller Manufacturing Corporation of Boston, Mass. Following his graduation from the University of Kansas in 1939, Mr. Lampton completed a two-year special machinist

Preston W. Lampton

apprenticeship with the St. Louis-San Francisco at Springfield, Mo. He had been employed as a draftsman in the office of the mechanical engineer of that railroad since January, 1941.

Gordon L. Leach has been appointed assistant to the president of the Hunt-Spiller Manufacturing Corporation. Mr. Leach was born in Boston, Mass., in 1905 and is a graduate of Philips Exeter Academy and Harvard University. He was formerly employed in the mechanical department of the Boston elevated railway, and joined the Hunt-Spiller Manufacturing Corporation as sales representative in 1930. During the past year he has been handling

Gordon L. Leach

affairs in connection with the Priority department, which duties he will continue.

◆

AMERICAN STEEL & WIRE CO.—*Cecil W. Guyatt,* formerly assistant chief industrial engineer, has been named chief industrial engineer of the American Steel & Wire Co. *John S. Conant* has been made priorities administrator, at the same time continuing as general supervisor of production planning, and *Lloyd W. Hackley,* formerly supervisor of production planning in the cold rolled department at the Cuyahoga works in Cleveland, Ohio, has been appointed assistant general supervisor of production planning for the entire company.

Army-Navy Production Awards

Recognition of high achievement in the production of war equipment has been made by the presentation of the Army-Navy "E" to the following companies:

Carnegie-Illinois Steel Corporation. Two stars affixed. Previous awards to this United States Steel Corporation subsidiary included the Bureau of Ordnance flag and the Navy "E" pennant, announced October 24, 1941, and, later, the All-Navy "E" burgee.

Union Asbestos & Rubber Company, Paterson, N. J., plant.

DAMON DEB. WACK, assistant to the president of the National Bearing Metals Corporation, has been elected executive vice-president of that company in active charge of all plants. Until his appointment as assistant to the president of the National Bearing Metals Corporation about a year ago, Mr. Wack was vice-president of the Pacific coast division of the parent corporation, the American Brake Shoe & Foundry Co.

◆

NATIONAL MALLEABLE & STEEL CASTINGS COMPANY.—*Wilson H. Moriarty,* assistant to the first vice-president of the National Malleable & Steel Castings Co., has been promoted to the position of assistant to the president, and *Walton L. Woody,* plant manager at Sharon, Pa., has been promoted to the position of assistant to the president in charge of the Sharon, Pa., and Melrose Park, Ill., steel castings plants.

Obituary

FRANK A. KRONER, transportation specialist of the General Electric Company's transportation department, Atlanta, Ga., died November 28 in that city.

◆

ELMER H. FATHAUER, sales agent of the National Malleable & Steel Castings Co., in St. Louis, Mo., died in Decatur, Ill., on November 19. He was 47 years of age.

◆

HARTE COOKE, senior engineer of the Diesel engine division of the American Locomotive Company at Auburn, N. Y., died December 14. He was 71 years old.

◆

DAVID S. YOUNGHOLM, vice-president of the Westinghouse Electric & Manufacturing Co. in charge of the lamp division at Bloomfield, N. J., has died.

◆

ROBERT H. WEATHERLY, president of the Pilliod Company since 1910, died December 1. He was 68 years of age. During his career Mr. Weatherly had been an assistant superintendent of the Scarritt Car Seat Works; assistant to the vice-president of the American Steel Foundries, and vice-president of the Scullin Steel Company.

◆

WILLIAM H. FENLEY, western manager of the Kerite Insulated Wire & Cable Company at Chicago, died on November 22.

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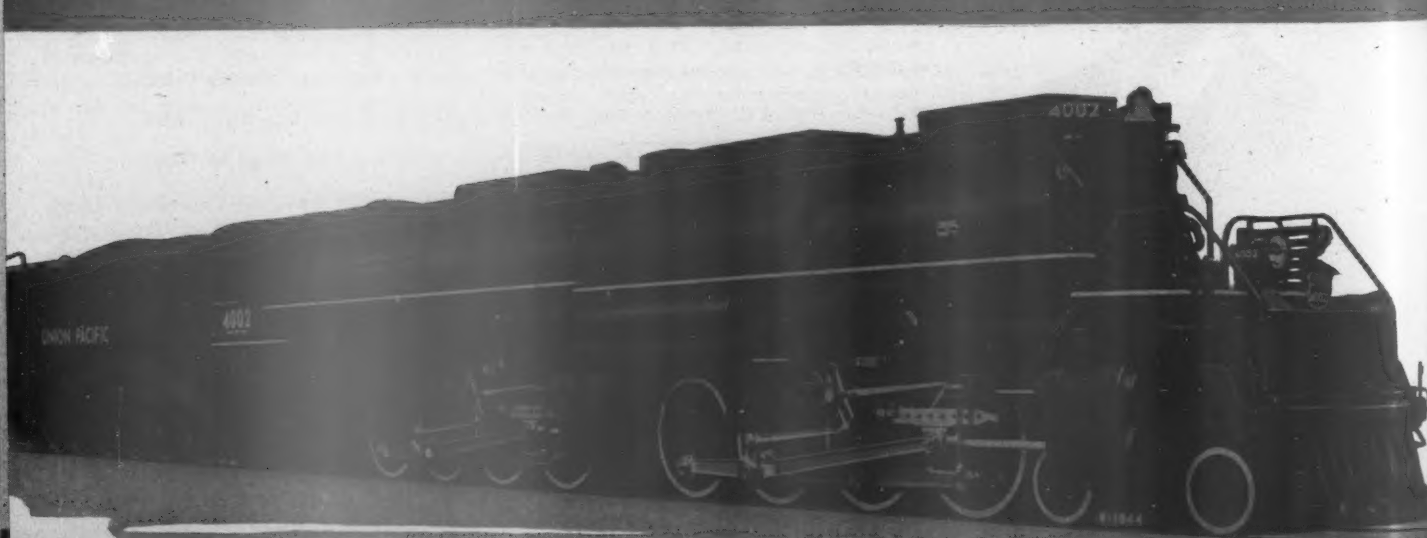
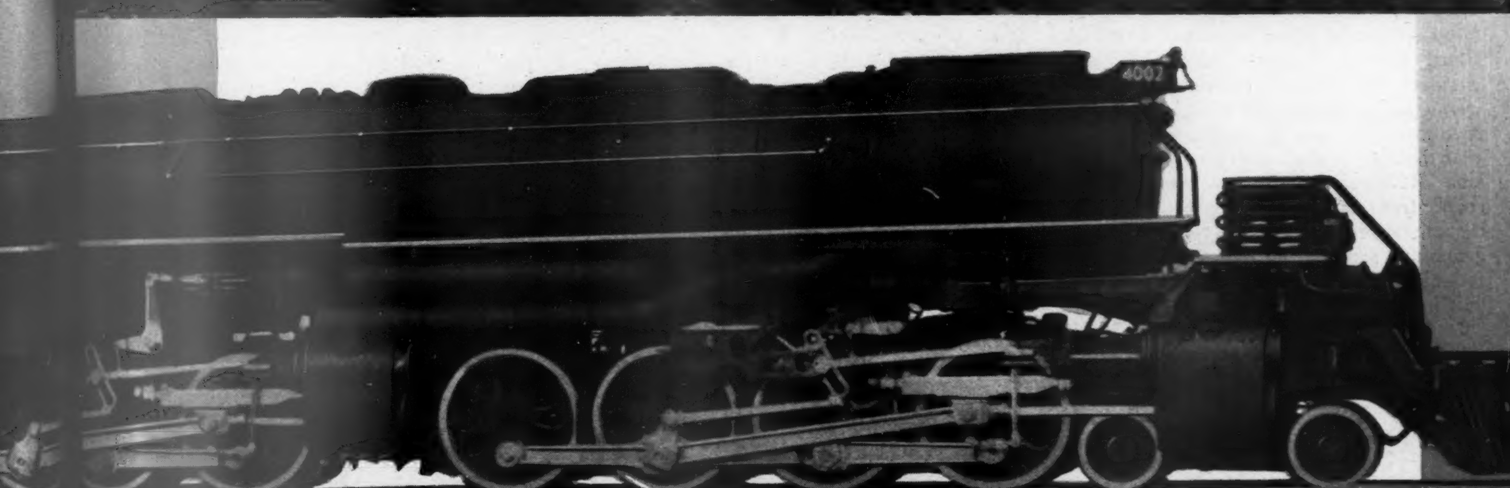
"BIG BOY"





"Big Boy"—the world's largest and most powerful steam locomotive.

Not just one, but twenty of these gigantic locomotives are giving remarkable and outstanding performance in the movement of war traffic in the mountainous western territory of the Union Pacific —"The Strategic Middle Route" to and from all the West.

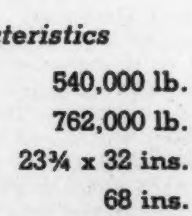
Locomotive Characteristics

Weight on Drivers	540,000 lb.
Weight of Engine	762,000 lb.
Cylinders (Four)	23¾ x 32 ins.
Diameter of Drivers	68 ins.
Boiler Pressure	300 lb.
Tender Capacity—Fuel	28 tons
Tender Capacity—Water	24,000 gals.
Tractive Power	135,375 lb.

AMERICAN LOCOMOTIVE

Manufacturers of Mobile Power

Steam, Diesel and Electric Locomotives, Marine Diesels, Tanks, Gun Carriages and other Ordnance



Mr. Fenley was born at Greenwood, Ind., May 7, 1876, and entered railway service in September, 1895, as a brakeman of the Cleveland, Cincinnati, Chicago & St. Louis. In the following year he was promoted to yard master and in 1898 was employed by the National Switch & Signal Co. In the

William H. Fenley

same year he returned to the Big Four, where for two years he was towerman and signal maintainer. He resigned in 1900 to enter the employ of the Chicago Great Western and during the next 11 years held the positions of signal foreman, electrician, signal inspector, signal supervisor, office engineer and signal engineer. In 1911, he was a sales engineer of the Union Switch & Signal Co. and in September of that year became signal engineer of the Panama Railroad, where he put "standard code" train operation in effect and later became superintendent of telephone, telegraph and signals. He also built the trans-Isthmian duct line and underground conduit in the Panama fortifications. In June, 1915, he entered the employ of the Kerite Insulated Wire & Cable Co. and in 1922 was promoted to western manager. He was president of the National Railway Appliances Association in 1930-31 and president of the Railway Electric Supply Manufacturers Association in 1925-29.

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Walter P. Murphy, chairman of the Standard Railway Equipment Manufacturing Company, Chicago, and head of numerous other railway equipment manufacturing companies, died suddenly at the Ambassador hotel, Los Angeles, Calif., on December 16, following a heart attack. Walter Patton Murphy was born at Pittsburgh, Pa., on January 26, 1873. In the 1880's his father sent the family to western Kansas to live on 160 acres of land, which he had acquired, while he continued to work elsewhere in railroad shops. After several years the family returned to East St. Louis, Ill., where Mr. Murphy's father was trying to manufacture a box-car roof that he had invented. Mr. Murphy, who was then 16, entered railway service in a machine shop; and later became successively a fireman and locomotive engineer. While working, he also found time to study part-time at St. Louis University and after finishing as much college work as he could find time for, was appointed a foreman of the Missouri Pacific shops at Coffeyville, Kan., later being promoted to the position of foreman of the St. Louis shops and then going with the Union Pacific. In 1898 he left railroad service to join his father in the equipment manufacturing business. At that time one of the great difficulties that confronted the railroads was the tendency of freight to knock out the ends of box cars under the stresses created by sudden stops and starts. To overcome this, Mr. Murphy developed the corrugated steel end for box cars. He also developed a method of rebuilding old freight cars to increase their capacity and enable them to accommodate automobiles and improved the design of refrigerator cars, increasing their floor space and making it possible to maintain an even low temperature throughout, which greatly facilitated the transportation of perishables. In addition, Mr. Murphy continued his father's work on the design of car roofs, on which feature alone he held more than 40 patents. Mr. Murphy was chairman of the Standard Railway Equip-

W. P. Murphy

ment Company; president of the Metal Products Company; and president of the Standard Railway Devices Company.

In 1939 he contributed nearly $7,000,000 for the construction and equipping of the new Technological Institute of Northwestern University at Evanston, Ill., an engineering school which features co-operative courses. The Institute as it was formally dedicated on June 15 and 16, 1942, is described on page 324 of the July, 1942, *Railway Mechanical Engineer*

Personal Mention

General

William Q. Daugherty, whose promotion to assistant superintendent of motive power and car equipment of the Gulf, Mobile & Ohio, with headquarters at Jackson, Tenn., as reported in the December issue. Mr. Daugherty was born at Verona, Miss., and entered railway service in 1892 in the Decatur (Ala.) shops of the Louisville & Nashville, later serving three years in road service as a locomotive fireman. In August, 1898, Mr. Daugherty went with the Mobile & Ohio (now part of the Gulf, Mobile & Ohio) as a locomotive fireman and two months later was promoted to the position of enginehouse foreman at E. St. Louis, Ill. In March, 1901, he was appointed traveling fireman and a year later returned to E. St. Louis as enginehouse foreman. In May, 1903, he became general foreman at Meridian, Miss., and in February, 1911, he was appointed master mechanic at Jackson, Tenn. He became assistant superintendent of motive power and car equipment on November 1, 1942.

William Q. Daugherty

Master Mechanics and Road Foremen

J. A. Dempster has been appointed master mechanic of the Gulf, Mobile & Ohio, with headquarters at Jackson, Tenn.

H. L. Heinz has been appointed general road foreman of engines, Central Lines, of the Southern, at Knoxville, Tenn.

Harry E. Anderson, assistant division master mechanic of the Atchison, Topeka & Santa Fe at La Junta, Colo., has been appointed to the newly created position of master mechanic of the Western division with headquarters at Dodge City, Kan., as announced in the December issue. Mr. Anderson was born on May 12, 1897, at Los Animas, Colo., and after completing high school in June, 1913, entered the mechanical department of the Atchison, Topeka & Santa Fe at La Junta as a boilermaker apprentice. He was a machinist ap-

prentice from October 13, 1913, to October 31, 1917, at La Junta and a machinist at the La Junta enginehouse until May 23, 1918, when he enlisted in the U. S. Navy. He returned to the Santa Fe on March 18, 1919, as a machinist at La Junta. On

H. E. Anderson

April 1, 1919, he became assistant day enginehouse foreman; on July 28, 1920, night enginehouse foreman; on January 15, 1923, day enginehouse foreman; on September 1, 1927, general enginehouse foreman; on April 14, 1938, general locomotive foreman in the back shop; on May 19, 1941, assistant master mechanic, and on November 1, 1942, master mechanic, Western division, Dodge City, Kan.

William G. Ringland, assistant master mechanic of the New York Central, has been appointed master mechanic in charge of the motive power and car department,

W. G. Ringland

Pennsylvania division, with headquarters as before at Avis, Pa., as announced in the December issue. Mr. Ringland was born on September 28, 1888, at York, N. Y., and was graduated from high school at Oswego, N. Y., in 1905. He entered the employ of the New York Central on June 13, 1905, as a machinist apprentice and subsequently served as a machinist at the Oswego shops. On September 16, 1910, he became piecework inspector at the Oswego engine terminal and later terminal foreman at Ogdensburg, N. Y., and Watertown. Mr. Ringland was appointed to the position of assistant master mechanic, motive power department, Pennsylvania division, with headquarters at Avis, Pa., on October 16, 1939.

Car Department

R. H. Dyer, general car inspector of the Norfolk & Western at Roanoke, Va., has retired. Mr. Dyer had been in the employ of the Norfolk & Western since 1895.

C. H. Wright, general car inspector of the Boston & Albany at Boston, Mass., has been appointed division general car foreman, with headquarters at Beacon Park, Allston, Mass.

J. D. Rezner, general car foreman of the Chicago, Burlington & Quincy, has been promoted to the newly created position of superintendent of the car department, with headquarters at Chicago.

Shop and Enginehouse

Charles L. Lehnis, a machinist in the employ of the Chesapeake & Ohio at Handley, W. Va., has been promoted to the position of enginehouse foreman at Handley.

Purchasing and Stores

Charles C. Hubbell, general purchasing agent of the Delaware, Lackawanna & Western at New York, retired on January 1, 1943, after 47 years of service.

Obituary

J. F. Nicks, general car foreman of the Gulf, Mobile & Ohio at Whistler, Ala., died on December 3.

Irwin Ashton Seiders, retired superintendent of motive power and rolling equipment of the Reading Company, died on December 14, at his home at Reading, Pa. Mr. Seiders, who was born on October 23, 1864, was educated at the Tamaqua (Pa.) high school and entered railway service in January, 1882, as a laborer on the Reading. From 1883 to 1907, Mr. Seiders served successively as depot hand, brakeman, fireman, engineman, extra passenger engineman and as regular passenger engineman at Tamaqua. On the latter date, He was promoted to the position of road foreman of engines at Reading, and in 1914 became fuel inspector. In October, 1915, Mr. Seiders was appointed superintendent of motive power and rolling equipment, with headquarters at Reading, in which capacity he served until August, 1932.

Henry Hague Vaughan, at one time head of the mechanical department of the Canadian Pacific, died on a visit to Philadelphia, December 11. Mr. Vaughan was born at Forest Hill, England, December 28, 1868. He came to this country in 1891 and entered the employ of the Great Northern in the mechanical department at St. Paul, Minn. Seven years later he became mechanical engineer of the Q and C Company and the Railroad Supply Company, Chicago. In 1902 he was appointed assistant superintendent motive power, Lake Shore & Michigan Southern. Two years later, in 1904, he became superintendent motive power of the Eastern Lines of the Canadian Pacific. He was promoted to the position of assistant to the vice-president in the following year. He went with the Dominion Bridge Company in 1916 as a vice-president and was engaged in the manufacture of munitions in Canada during the first World War. For many years Mr. Vaughan acted as a consulting engineer, with headquarters in Montreal, and was associated with the Canadian Foreign Investment Corporation, Ltd., and the Companhia Brasileira de Cimento Portland, a South American cement concern. He was a former president of the Engineering Institute of Canada and served a term as vice-president of the American Society of Mechanical Engineers, of which he was elected an Honorary Member in 1939.

Trade Publications

Copies of trade publications described in the column can be obtained by writing to the manufacturers, preferably on company letterhead, giving title. State the name and number of the bulletin or catalog desired, when it is mentioned.

Hardsteel Tools.—Black Drill Co., 5005 Euclid avenue, Cleveland, Ohio. Illustrated booklet descriptive of Hardsteel in drills, reamers, tool bits and special tools.

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Preheating Chart.—Tempil Corporation, 132 West Twenty-second street, New York. Chart covers correct preheat temperatures and other pertinent data for 79 principal ferrous and non-ferrous alloys.

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Steam Hose.—The B. F. Goodrich Company, Akron, Ohio. Revised catalog page contains easy-to-read rules for the care and maintenance of steam hose, also data on inside and outside diameters, weight and number of plies.

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Whiting Products.—Whiting Corporation, Harvey, Ill. "Whiting Products for Industry," Book No. 236, gives pertinent data on cranes, railroad and aviation equipment, cupolas and foundry equipment, etc.

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Locomotive Packings and Insulation.—Union Asbestos & Rubber Co., Chicago. Eight page, 6-in. by 9-in. catalog contains specific information and illustrations covering the use of Unarco products for packing locomotive air pumps, feed water heaters, cab cocks and power reverse gears and insulating high-pressure steam pipes.

◆

NE Steels.—Joseph T. Ryerson & Son, Inc., Sixteenth and Rockwell streets, Chicago. "National Emergency Steels" tells what NE steels are; explains step by step the Jominy end quench hardenability test for determining heat-treatment response, and lists various NE steels as suggested alternates for standard compositions in the carburizing, medium hardening, and high hardening groups.

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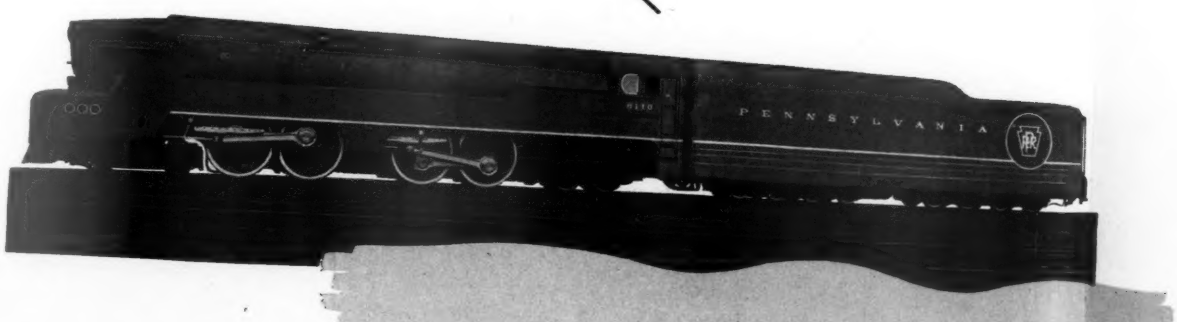
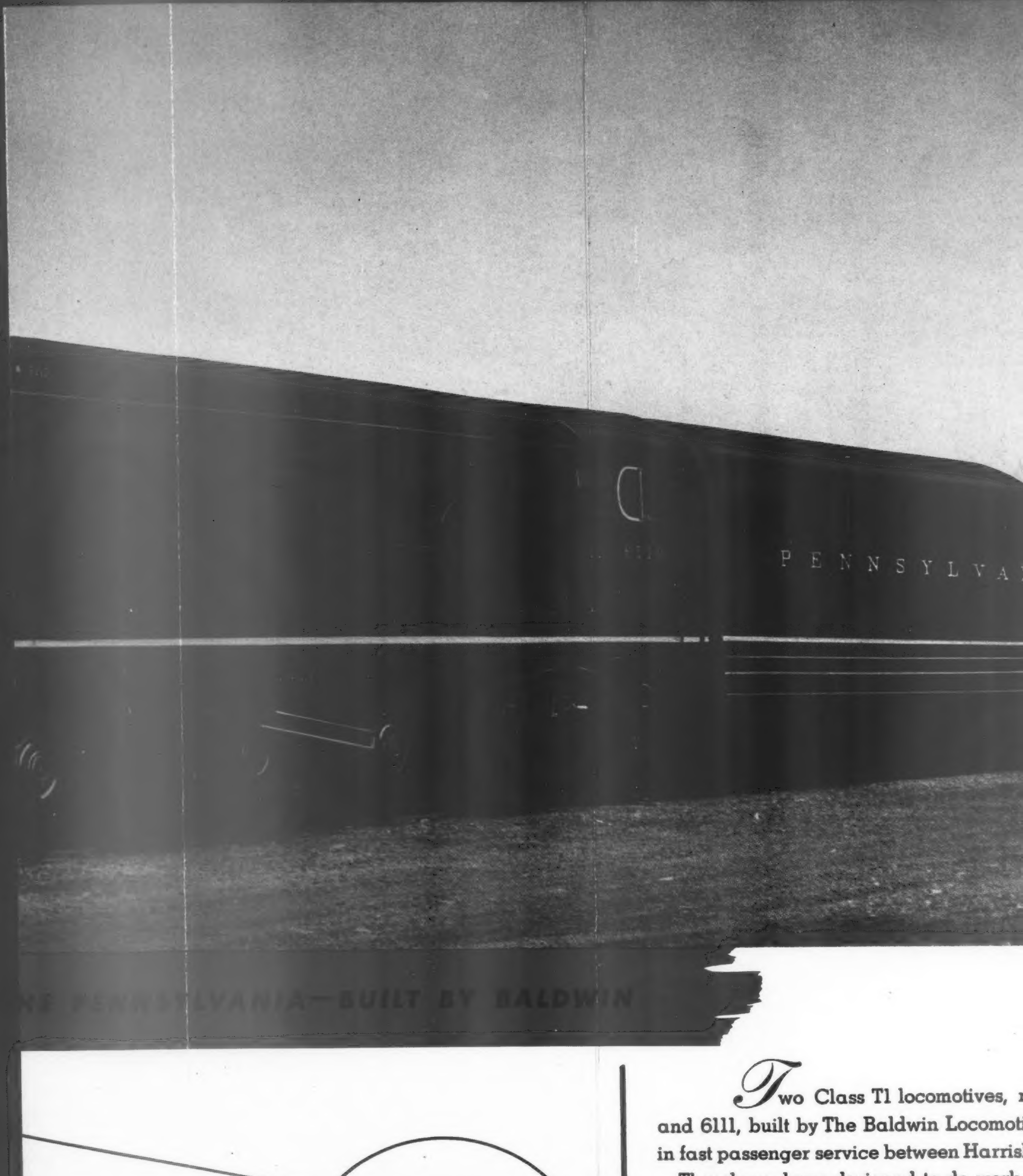
THE LATEST POWER FOR THE PENNSYLVANIA—BUILT BY





HE PENNSYLVANIA—BUILT BY BALDWIN

Two Class T1 locomotives, n
and 6111, built by The Baldwin Locomoti
in fast passenger service between Harrisb

They have been designed to do work
territory corresponding to that done by
locomotives, Class GG1, in electrified te
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The T1 locomotives, general specifica
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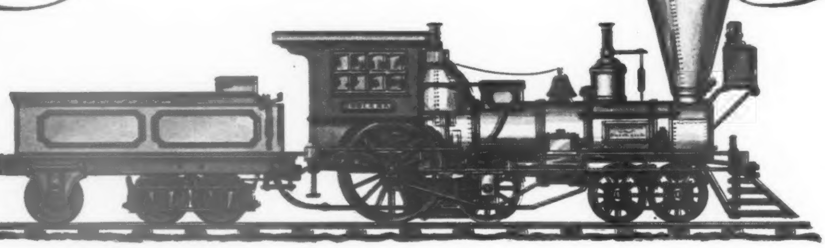
The Latest Power for the Pennsylvania

by

BALDWIN



THE **first**

THE **latest**

Specifications

BALDWIN POWER FOR THE PENNSYLVANIA

In July, 1849, Baldwin completed the "Mifflin", a fast passenger locomotive, which was the first Baldwin engine to be placed in service on the new line extending from Harrisburg to Lewistown. Two similar locomotives, the "Blair" and "Indiana", were built for the Pennsylvania by Baldwin later in the same year, 1849.

These locomotives had a single pair of driving wheels back of the firebox, one pair of carrying wheels in front of the firebox, and a four-wheeled truck under the front end. An unusual feature was a "traction increaser" for the purpose of transferring weight from the carrying wheels to the drivers in starting, thus increasing the adhesion.

The new streamlined T1's, now in service on the Pennsylvania from Harrisburg to Chicago, are the latest locomotives of a very large number which Baldwin has built for the Pennsylvania since this great system was organized on February 25, 1847.

BALDWIN LOCOMOTIVE FOR THE PENNSYLVANIA

SPECIFICATIONS OF THE LATEST POWER FOR THE PENNSYLVANIA

Gauge	4' 8½"
Cylinders (4)	19¾" x 26"
Valves	Poppet type

BOILER

Type	Modified Belpaire
Diameter	F. 91½" B. 100"
Working pressure	300 lb.
Fuel	Bituminous coal

Firebox

Material	Steel
Staying	Radial
Length	138"
Width	96"
Comb. Cham. Length	96"

Tubes

Diameter	5½"	2¼"
Number	69	184
Length	18' 0"	18' 0"

Heating Surface

Firebox	269 sq. ft.
Combustion chamber	150 sq. ft.
Tubes 2¼"	1940 sq. ft.
Tubes 5½"	1779 sq. ft.
Circulators	71 sq. ft.
Total	4209 sq. ft.
Superheater	1680 sq. ft.
Grate area	92 sq. ft.
Firebox volume	641 cu. ft.

DRIVING WHEELS

Diameter, outside	80"
Diameter, center	72"
Journals, main— 11½" diam. roller bearing	
Journals, others— 11½" diam. roller bearing	

ENGINE TRUCK WHEELS

Diameter, front	36"
Journals— 7" diam. roller bearing	
Diameter, back	42"
Journals— 8" diam. roller bearing	

WHEEL BASE

Driving	25' 4"
Rigid	18' 5"
Total engine	51' 11"
Total engine & tender	107' 0"

WEIGHT, *in Working Order*

On driving wheels	268,200 lb.
On truck, front	100,200 lb.
On truck, back	128,800 lb.
Total engine	497,200 lb.
Total tender, fully loaded	433,000 lb.
(Average weight per pr. drivers	67,050 lb.

TENDER

Wheels, number	Sixteen
Wheels, diameter	36"
Journals— 6½" diam. roller bearing	
Tank capacity	19,500 U.S. gal.
Fuel capacity	41 tons
*Tractive force	65,000 lb.
Service	Passenger

Equipped with Type "A-S" superheater, feed water heater, stoker, five circulators, power reverse, one piece cast steel locomotive bed with integral cylinders, and air brake on all front truck, trailer truck, driving and tender wheels, with two 8½" cross-compound air pumps.

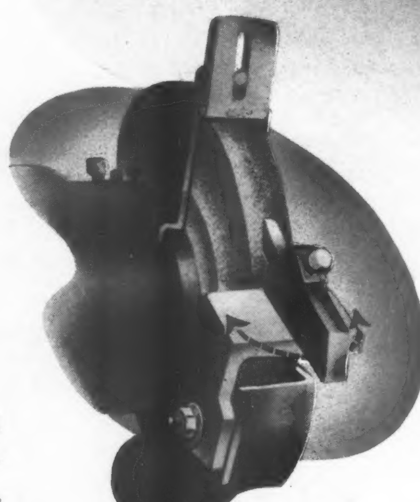
*Booster (estimated to develop 13,500 lb. tractive force), on engine 6111 only.

I'm Tellin' You..

No. 5 in a Series of Tips on "Keeping 'em Turning"
by John Stephens, 41 years at LeBlond

One of the most common causes of trouble in lathe work is a dull or improperly ground tool. I'd like to illustrate a few of the correct steps for giving first aid to "beat up" tools. The best method is the semi-automatic grinding machine.

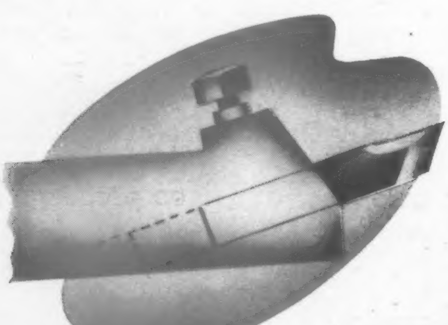
If your tool room has one, let the expert in charge do your grinding. But if you do your own grinding by the offhand method, watch these points.



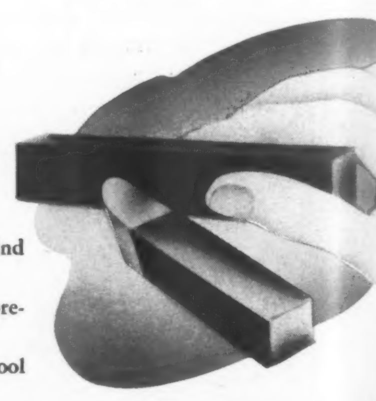
1. To cut free a tool must be ground with four correct angles—side clearance (top drawing) and back rake, side rake, and end clearance (shown on bottom drawing). These angles well as the shape of the tool vary with the material to be chined. Refer to a tool manufacturer's manual.

3. The tool is supported on the work moved with a rocketing motion over the the entire grinding wheel. This prevents from turning and distributes wear on the

4. Tools used for finishing or for soft should be further sharpened with light an India oil stone. Use of this stone is ommended between cuts. For roughing step is unnecessary.



2. The most satisfactory way to grind a tool bit is in its own holder. To prevent grinding the holder, extend the tool beyond its regular cutting position.



ARMY E NAVY

THE R. K. LeBLOND MACHINE TOOL C

Cincinnati, Ohio

Largest Manufacturer of a Complete Line of La